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THIRD EDITION
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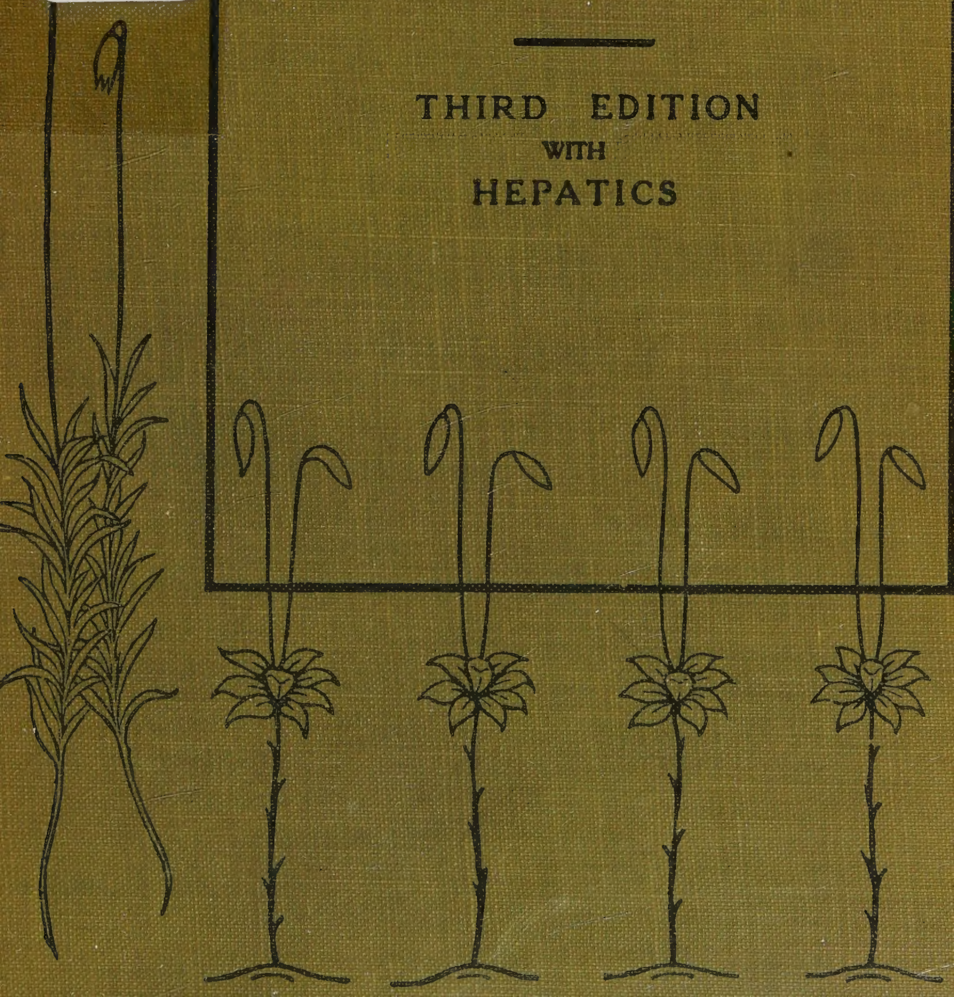

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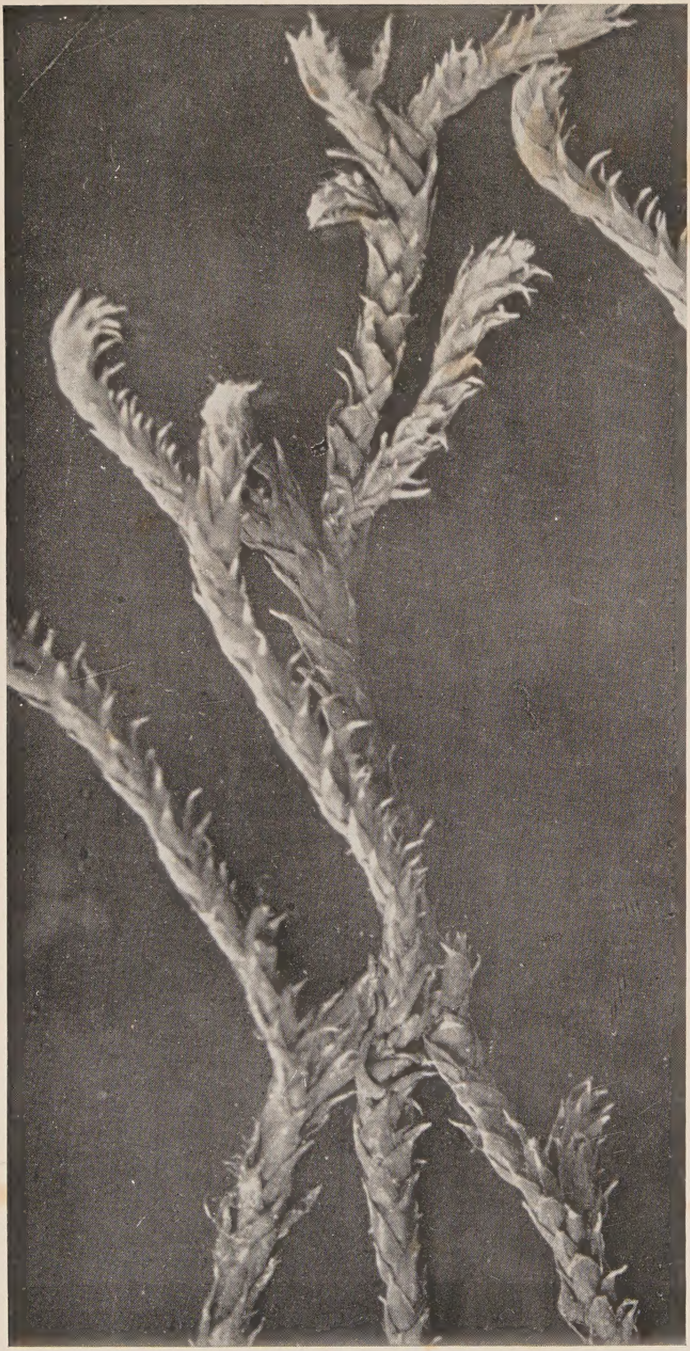

Hedwigia allicans, × 8.

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MOSSES WITH A HAND-LENS

THIRD EDITION

A Popular Guide to the Common or Conspicuous
Mosses and Liverworts of the North-Eastern
United States

BY

A. J. GROUT, Ph.D., and

Fellow A.A.A.S., Member Botanical Society of America

Author of Mosses with a Hand-lens, Mosses with Hand-lens
and Microscope, Moss Flora of New York City and
Vicinity. Founder and Associate Editor of the
Bryologist. Chairman of the Department of
Natural Sciences, Curtis High School, New
Brighton, Richmond Boro, New York City.

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Liverworts by M. A. Howe, Ph.D.

*Illustrated with photographs by the author and others, drawings by
Mary V. Thayer and reproductions of plates from Sullivant's
Icones and the Bryologia Europea.*

Published by the Author
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5815

PREFACE TO THE THIRD EDITION.

The first edition of this book, because of its experimental nature, was limited in matter and illustration by the lack of knowledge as to just the nature of the work that would be most useful and by the limited means at command for illustration and publication. The second edition was given the benefit of the experience obtained with the first.

In three respects the second edition will be improved upon in the third: the Hepaticae are more satisfactorily and completely treated by a specialist in that group, Dr. M. A. Howe; the introductory part has been made much fuller to serve the purpose of a textbook in schools and colleges; the numerous photographs of both mosses and hepatics add greatly to the usefulness of the book and add even more to the attractiveness of its appearance.

The full value of the additional introductory material will not be available without the aid of a compound microscope, yet a knowledge of the facts there set forth will be of interest to every student.

The new matter on the structure and life history of the mosses has been adapted largely from the author's larger book, Mosses with Hand-lens and Microscope. Considerable new material concerning the structure and life history of the hepatics is given both in the text and in the glossary.

The author has been surprised to learn that some have failed to use previous editions successfully because of inability or unwillingness to use a hand-lens properly. Such persons will find that most species can be determined without any magnification whatever or by the use of a good reading glass which even a child can use with ease. It is hoped that the appendix will help and encourage such students.

But it must be borne in mind by the student that the present work is limited and incomplete in its treatment, and is but a stepping stone to the larger and more complete works, and to the broader and fuller study of bryology.

My thanks are due Miss Thayer for her care in preparing the drawings which bear her initials; to Dr. Evans for the use of some of his illustrations; to Miss Helen E. Greenwood, Prof. Geo. E. Nichols, D. Lewis Dutton, A. T. Beals and others for photographs; and to Dr. M. A. Howe for his skillful and scholarly work on the hepatics.

A. J. GROUT.

Curtis High School, New Brighton,
New York City, N. Y., October, 1924.

KEY TO THE FAMILIES OF MOSSES.

In using these keys the student is advised to turn to the illustrations in the main part of the book to explain any of the characters used in the key that are not otherwise perfectly clear. A free use of the glossary is also suggested.*

PAGE

1. Plants whitish or light gray, scarcely appearing green . . . . 2.
   Plants green, yellow-green, or dark green to almost black . . . . 3.
2. Plants of bogs; capsules nearly globular, ovoid when dry and empty, without peristome or beaked operculum . . . . *Sphagnaceae.* 28
   Plants of moist shady places, growing in dense tufts or cushions; capsules elongated, with beaked operculum and a peristome. *Leucobryum* in *Dicranaceae.* 85
3. Leaves in two rows, with edges apparently towards the stem; plants apparently flattened . . 4.†
   Leaves in more than two rows, or if apparently two ranked, the edges of the leaves are not towards the stem . . . . 5.
4. Leaves apparently split on the inner edge and sheathing each other and the stem, costate; peristome present, operculum beaked; common. . . . . *Fissidentaceae.* 59
   Leaves ecostate, not split at base, but forming a continuous wing-margin along the stem in the sterile plants; peristome lacking; protonema luminous; rare plants of caves. *Schistostegaceae.* 126
5. Acrocarpous . . . . 6.
   Pleurocarpous . . . . 20.
6. Plants black or blackish green except tips of growing stems; leaves opaque or nearly so because of the very thick cell-walls; growing on trees or rocks. . . . . 7.

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* See appendix p. 332. † Some hepatics will be sought here.

PAGE

Plants green to light yellow-green, or, if blackish, growing on soil........................ 9.

7. Capsule dehiscing by four valves, as in the Hepaticæ, almost exclusively alpine or subalpine ....*Andreaeaceae.* 37

Capsule dehiscing by an operculum; peristome of 16 jointed teeth...................... 8.

8. Peristome single (very rarely lacking), with teeth not united in pairs, but usually perforate or bifid, richly colored and rarely reflexed when dry. Plants often hoary with colorless leaf apices, nearly all growing on rocks ....*Grimmiaceae.* 87

Peristome double (with one or two exceptions), teeth often united in pairs, rarely perforate, usually reflexed when dry, inner peristome of very narrow linear erect segments. Plants very rarely hoary, mostly tree-growing.* *Orthotrichaceae.* 116

9. Peristome of four large distinct unjointed teeth. *Georgiaceae.* 38

Peristome having an inner plaited whitish cone; outer peristome of shorter teeth often present. Odd plants best recognized by a reference to the illustrations.......*Buxbaumiaceae.* 56

Peristome lacking, or of more than four teeth....10.

10. Peristome of 32 to 64 short teeth, joined at the tips to a membrane which nearly closes the mouth of the capsule; calyptra densely hairy with long whitish hairs (except *Catharinea*); leaves with numerous vertical lamellae on the upper surface of the costa. Plants large and usually very dark colored, growing on soil. *Polytrichaceae.* 40

Peristome when present consisting of 16 to 32 plainly articulate teeth, frequently lacking; mouth of capsule not closed by a membrane..11.

11. Capsules cleistocarpous....*Bruchia* in *Dicranaceae.* 66

---

* See *Orthotrichum anomalum* and *Ulota americana.*

PAGE

Capsules cleistocarpous.....*Astomum* in *Tortulaceae.* 67

Capsules gymnostomous; leaf-cells small, dense. *Pottia* and *Weisia* in *Tortulaceae.* 134, 103

Capsules gymnostomous; leaf-cells large, clear. *Physcomitrium* in *Funariaceae.* 132

Capsules peristomate........................13.

13. Capsules with a large swollen hypophysis, which is usually larger and more conspicuous than the spore-bearing part; leaves not papillose; growing on decaying animal matter. *Splachnaceae.* 128

Capsules without hypophysis (some with slender necks)..................................14.

14. Capsules strongly plicate when dry and empty, often strongly unsymmetric.................15.

Capsules not plicate or striate when dry or only very slightly so..........................18.

15. Peristome single.....................*Dicranaceae.* 62

Peristome double............................16.

16. Capsules subglobose; inner peristome without cilia, or cilia very small...........*Bartramiaceae.* 137

Capsules elongated, cilia well developed.........17.

17. Capsules strongly unsymmetric with the mouth nearly on one side; segments opposite the teeth............................*Funariaceae.* 129

Capsules only slightly unsymmetric; segments alternating with the teeth.......*Aulacomniaceae.* 135

18. Capsules subpendent to pendent; peristome double ....*Bryaceae.* 141

Capsules often unsymmetric or inclined, but never subpendent; peristome single, teeth usually forked or twisted or both............19.

19. Leaves nearly always crisped when dry; peristome in most cases of filiform twisted teeth. *Tortulaceae.* 100

Leaves rarely crisped; peristome of 16 reddish forked teeth which are never twisted. *Dicranaceae.* 62

20. Aquatic, long and floating, with leaves straight; or plants shorter with falcate-secund leaves

PAGE

and often only partially submerged; capsules immersed or emergent, never exserted. *Fontinalaceae.* 219
Terrestrial (or a few aquatic), seldom slender or floating; capsules exserted on long setæ.....21.
21. Tree-growing species with the capsules partially immersed in the perichaetial leaves or at most barely exserted......................23.
Not growing on trees, or if so with capsules long exserted..........................22.
22. Leaves subopaque, dense, usually small; leaf-cells short.......................*Leskeaceae.* 160
Leaves nearly transparent, leaf-cells in most cases elongated; peristome with cilia except in species with erect capsules...............24.
23. Stems and branches flattened; leaves appearing two-ranked. ....*Neckeraceae.* 216
Stems and branches nearly terete; leaves not appearing two-ranked...............*Leucodon.* 215
24. Teeth of peristome reflexed when dry..*Anacamptodon.* 213
Teeth of peristome merely spreading.....*Hypnaceae.* 170

KEY TO GENERA.

Plants with luminous protonema, growing exclusively in caves and dark holes....*Schistostega.* 126
Plants gray to gray-green, growing in bogs and swamps..........................*Sphagnum.* 30
Plants not gray (except *Leucobryum*) growing in various situations...................... 1.
1. Acrocarpous.............................. A.
2. Pleurocarpous............................ B.

A.

1. Capsules square in cross-section; calyptra densely hairy.........................*Polytrichum.* 41
Capsules round in cross-section; calyptra extinguisher-like, completely covering the capsule ....*Encalypta.* 114
Capsules round in cross-section; calyptra various. 2.

PAGE

2. Blackish to brownish green, growing on the bark of living trees........................ 3.
Blackish to brownish green, growing on rocks....34.
Green, growing in various situations but not on trees.................................... 5.
3. Capsule long-exserted, not wrinkled when dry... 4.
Capsule short-exserted, strongly wrinkled when dry; leaves crisped when dry.............*Ulota.* 117
Capsules immersed or partially exserted, strongly wrinkled (except *O. speciosum*) when dry; leaves not crisped.................*Orthotrichum.* 119
4. Leaves crisped; capsule pear-shaped and puckered about the mouth when dry...*Ulota Ludwigii.* 119
Leaves scarcely crisped, capsule ovoid, not puckered or folded................*Drummondia.* 116
5. Capsules immersed or partially exserted; seta not apparent............................ 6.
Capsules exserted; seta evident................. 9.
6. Capsules green, without distinct lid; plants of sandy fields............................. 7.
Capsules with lid and peristome; plants growing on shaded banks......................*Webera.* 57
7. Leaves strongly crisped to spirally coiled when dry..............................*Astomum.* 67
Leaves not crisped when dry.................. 8.
8. Capsules pear-shaped, partially exserted...*Bruchia.* 66
Capsules nearly spherical, immersed and nearly hidden in the long slender leaves....*Pleuridium.* 64
9. Capsules erect, urn-shaped, no peristome........10.
Capsules erect, greatly swollen at base....*Splachnum.* 128
Capsules strongly ventricose; mature plant without leaves........................*Buxbaumia.* 56
Capsules erect, ovoid to cylindric, nearly or quite straight..................................11.
Capsules arcuate, unsymmetric, usually cernuous..22.
Capsule symmetric, cernuous or pendent, ovoid, pyriform, or subglobose...................33.
10. Costa excurrent..........................*Pottia.* 134
Costa ending below apex of leaf.....*Physcomitrium.* 132
11. Plants growing on moist cliffs, usually on lime-

		PAGE
	stone; peristome lacking......... *Gymnostomum.*	102
	Plants growing on various substrata; peristome present..................................12.	
12.	Growing on stones in running water. *Fissidens Julianus.*	62
	Growing on rotten wood or occasionally on peaty banks.............................13.	
	Growing on soil.................................14.	
	Growing on rocks or cliffs..............*Dicranum.*	78
13.	Peristome of four teeth....................*Georgia.*	38
	Peristome of sixteen teeth......*Dicranum flagellare.*	83
14.	Plants with hairy calyptra and appearance of the hair-caps.....................*Pogonatum.*	48
	Plants without hairy calyptra..................15.	
15.	Peristome of 32 teeth attached to the columella as in the hair-caps.................*Catharinea.*	52
	Peristome of 32 hair-like, strongly twisted teeth; leaves crisped when dry....................16.	
	Peristome of 16 teeth often divided and slender at apex but not hair-like or twisted..........18.	
16.	Costa excurrent into a long white hair....*Tortula.*	111
	Costa not excurrent or barely so................17.	
17.	Basal hyaline cells forming a V at the base of the leaves..............................*Tortella*	108
	Line of separation between hyaline and dense cells running nearly straight across the leaf. *Barbula.*	105
18.	Leaves tongue-shaped with long-excurrent costa as in Tortula...........*Desmatodon plinthobius.*	112
	Leaves short, closely imbricated; not tongue-shaped ....*Ditrichum.*	67
	Leaves long and slender; lanceolate; costa not excurrent or only shortly so..................19.	
19.	Plants comparatively large; cells at basal angles of leaf abruptly enlarged and usually colored. *Dicranum.*	78
	Plants small; cells at basal angles of leaf not conspicuously enlarged or colored............20.	
20.	Plants rusty red; capsules more than twice as long as broad...........*Didymodon rubellus.*	69

PAGE

Plants green; capsule not more than twice as long as broad when moist..................21.

21. Plants of sandy fields; leaves crisped when dry. *Weisia viridula.* 103

Plants of moist banks; leaves not crisped. . *Dicranella.* 74

22. Plants greenish white................. *Leucobryum.* 85

Plants dark to light green, not white............23.

23. Leaves two-ranked; plants appearing flattened. *Fissidens.* 59

Leaves not two-ranked, arising from all sides of the stem.............................24.

24. Capsules smooth when dry....................25.

Capsules furrowed or wrinkled when dry........28.

25. Capsules with a long slender neck..... *Trematodon.* 73

Capsules with neck short or wanting............26.

26. Plants in habit, peristome, and calyptra like the hair-caps.................. *Pogonatum alpinum.* 50

Calyptra not hairy; peristome of 16 teeth.......27.

27. Peristome double; dry capsules usually with a short neck (long in *Pohlia elongata*). *Bryum* and *Pohlia.* 141, 147

Peristome single; capsules without neck, not strumose.......................... *Dicranum.* 78

Peristome single; capsule plainly strumose. *Oncophorus.* 70

28. Capsules subglobose when wet. *Philonotis* and *Bartramia.* 139, 137

Capsules elongated, often subcylindric..........29.

29. Growing on rotten wood............... *Dicranum.* 78

Growing on soil or bases of trees................30.

30. Growing in swamps or very wet places; peristome double........... *Aulacomnium palustre.* 135

Growing in barren places, roadsides, paths, etc.; peristome various........................31.

Growing on soil, base of trees, or rocks; peristome single...................... *Dicranella.* 74

Growing most commonly at base of trees in woods; peristome double. *Aulacomnium heterostichum.* 137

31. Capsules strongly curved, mouth at one side. *Funaria.* 129

PAGE

Capsules inclined, only slightly unsymmetric. . . .32.

32. Seta yellow. . . . .*Ditrichum pallidum.* 69

Seta dark red-brown. . . . .*Ceratodon.* 70

33. Leaves like those of *Dicranum longifolium* (see plate XI); seta arched in the middle; capsule without neck, pendent; peristome single. *Dicranodontium longirostre.* 83

Leaves lanceolate; seta bent at the top; capsule long-necked. . . . .*Leptobryum.* 85

Leaves lanceolate; capsule with short neck. *Pohlia nutans.* 147

Leaves broadly ovate-lanceolate to ovate. *Bryum* and *Mnium.* 141, 151

34. Leaves without costa. . . . . .35.

Leaves costate. . . . . .36.

35. Leaves acute, white tipped; capsules entirely immersed, subglobose, opening by a lid. .*Hedwigia.* 88

Leaves obtuse, without white tips; capsule splitting into 4 valves. . . . .*Andreaea petrophila.* 37

36. Leaves crisped when dry, never white tipped. *Ptychomitrium.* 89

Leaves not crisped, often white tipped. *Grimmia* and *Rhacomitrium.* 91

Leaves not crisped; capsule splitting into four valves. . . . .*Andreaea.* 37

Leaves not crisped, leaves never white tipped; capsules strongly plicate when dry and empty; peristome double. *Orthotrichum anomalum* and *Ulota americana.* 120, 119

B.*

1. Growing on stones in or near running water. . . . . . 2.

Not growing in water. . . . . 4.

Growing on the stems of partially submerged bushes. . . . .*Dichelyma.* 222

2. Long and floating (*Fissidens Julianus* may be sought here). . . . .*Fontinalis.* 224

Not long and floating. . . . . 3.

---

* Hedwigia may be sought here.

PAGE

3. Leaves without costa .... *Hypnum.* 195
Leaves costate.
Eurhynchium rusciforme, 196; *Brachythecium,* 197; *Amblystegium,* 193; *Hypnum ochraceum* 197.
4. Leaves two-ranked or appearing so, flattened into one plane .... 5.
Leaves not lying in one plane .... 7.
5. Leaves without costa .... 6.
Leaves costate; plants growing on cool moist rocks .... *Homalia.* 219
6. Plants growing on trunks of trees .... *Neckera.* 216
Plants growing on decayed wood.
Entodon and *Raphidostegium.* 207, 181
Plants growing on soil or decayed wood.
Plagiothecium. 205
7. Plants regularly once or twice pinnate, looking like miniature ferns.
Thuidium, Hypnum, Hylocomium proliferum. 164, 172, 168
Plants not regularly pinnate .... 8.
8. Capsules erect, straight .... 9.
Capsules cernuous, curved .... *Hypnum family.* 170
9. Growing on bark of trees .... 10.
Growing on soil or decayed wood .... 13.
Growing on stones or bark of trees.
Amblystegium adnatum. 181
10. Growing only near the base of trees .... 11.
Growing at various heights on tree trunks, seldom near the base .... 12.
11. Light green; branches julaceous .... *Thelia.* 163
Dark green; branches somewhat flattened or at least not julaceous .... *Anomodon.* 161
12. Small; seta many times as long as the perichætial leaves .... *Pylaisia.* 207
Larger; seta not more than twice as long as the perichætial leaves .... *Leucodon.* 214
13. Plants tree-like, growing on the ground in swamps .... *Climacium.* 211
Plants growing in prostrate mats on soil or decayed wood .... 14.

14. Leaves without costa .... *Entodon.* 207
Leaves costate ....
Anomodon rostratus and *Brachythecium acuminatum.* 162, 210

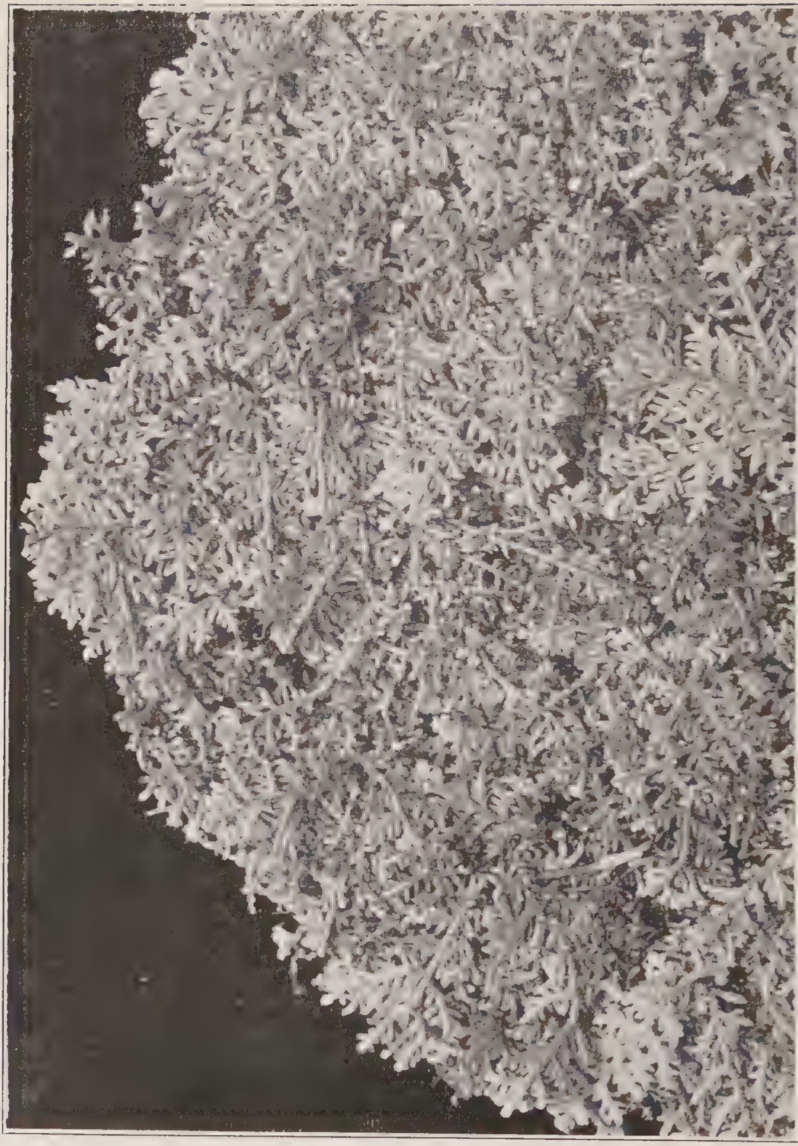

PLATE A. *Trichocolea tomentella.*

Photo by Prof. G. D. Smith

INTRODUCTION.

Mention mosses to almost any well-informed person and he will probably think of them as small plants of no special importance that grow chiefly on trees and stones, or in deep cool woods where moisture is abundant. Few people have any idea of the important part mosses play in human affairs or have any idea of how necessary they are to our comfort and convenience.

Accurately speaking, the mosses do not include the seaweeds or fresh water algae, which give us fertilizer, gelatine (agar-agar), iodine, and furnish the ultimate food supply for all kinds of fish and aquatic animals; or lichens, which are the pioneers that prepare the way for mosses and go far beyond them into arctic and alpine heights. Although not botanically related to the mosses the lichens are closely associated with them in the popular mind and are often found intermingled in growth.

Lichens are usually grayish or grayish green, sometimes bright colored, but seldom the plain green of most mosses, or blackish like the mosses of the rocks and tree trunks and none have distinct leaves borne on stems. The lichen is the first plant to grow on bare exposed rock even up into the snow line. It absorbs minerals from the rocks and carbon dioxide from the air, it collects dust and particles of crumbled rock until tiny patches and pockets of soil are formed, sufficient to hold and germinate the spores of various drouth resisting mosses.

Listen to one of our greatest apostles of the beautiful in art and nature. "Lichen and mosses,—how of these? Meek creatures. the first mercy of the earth, veiling with hushed softness its dintless rocks, creatures full of pity, covering with strange and tender honor the scarred disgrace of ruin,—laying quiet finger on the trembling stones, to teach them rest. How is one to tell of the rounded bosses of furred and beaming green,—the starred divisions of rubied bloom fine-filmed, as if the Rock Spirits could spin porphyry as we do glass."

"Yet as in one sense the humblest, in another they are the most honored of the earth-children. Unfading as motionless, the worm frets them not, and the autumn wastes not. Strong in lowliness, they neither blanch in heat nor pine in frost. To them, slow-fingered, constant-hearted, is entrusted the weaving of the dark eternal tapestries of the hills. Sharing the stillness of the unimpassioned rock, they also share its endurance; and while the winds of departing spring scatter the white hawthorn blossoms like drifted snow, and

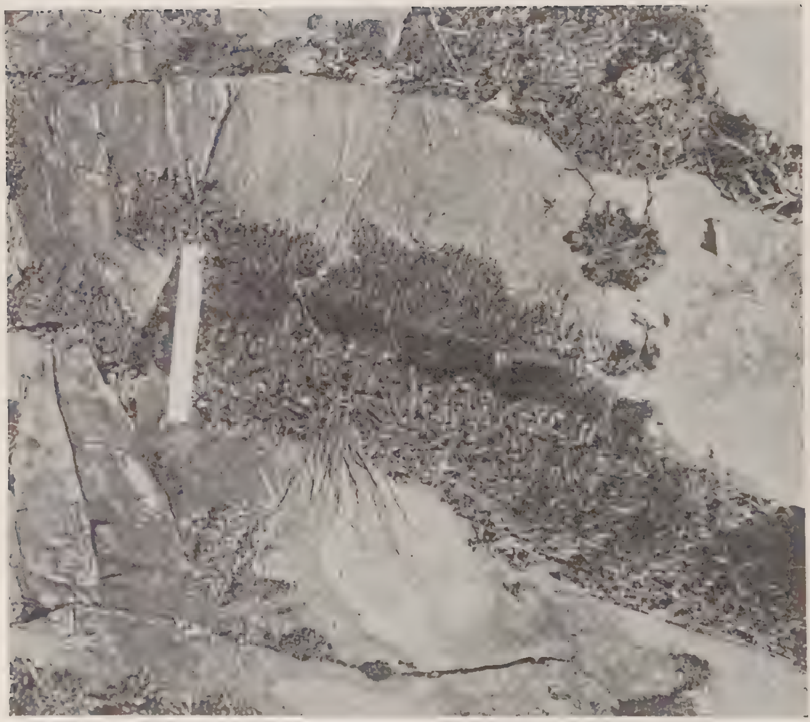

PLATE I. "Moss-created" soil, *Hedwigia*, *Dicranum scoparium* and *Polytrichum* on trap rock. Photo. by Dr. G. E. Nichols.

PLATE II. "A good stand of undersized spruces."

summer dims on the parched meadow the drooping of its cowslip gold,—far above among the mountains, the silver lichen-spots rest star-like, on the stone; and the gathering orange stain upon the edge of yonder peak reflects the sunsets of a thousand years."

While the poetry of these sentences is appreciated, the facts are usually unnoticed. So great is the independence of these plants of variations of climate, that one of the rock-growing Grimmias retained its vitality for over a year dried and preserved in a botanist's herbarium, and developed fresh growing plants when moistened.

In damp weather the mosses grow with surprising rapidity, in dry or frozen periods they stand and wait. Their stems dying below and growing above add still more plant-supporting soil to that prepared by lichens until grasses and herbs and finally shrubs and forest trees can get a foothold. Over acres on my "Moss Rock" retreat in the Green Mountains the soil will average scarcely a foot thick, yet there is a good stand of rather undersized spruces and hemlocks with so little a foothold that the cutting of a few trees in an exposed place leads to the overturning of many others, caught by the winter winds and bowled over like gigantic ninepins.

Let a fire get into these woods as it did into the Adirondacks some years ago and the soil, being of this vegetable origin, will burn down to the primeval rock, leaving bare and desolate the barren framework of Mother Earth. Compare the deep luxuriance of our Green Mountain slopes with the desolation of the fire-swept mountains of the Adirondacks or the Rockies and the value of the age-long work of mosses will be emphatically indicated.

The moisture-conserving and flood-preventing value of the great forest reserves of state and Federal ownership is due to this same moss-created and moss-carpeted layer of soil. Trees themselves hold back but little of the flood waters; it is the mosses that flourish in their shade that do the work. But the mosses found in this spongy carpet are mainly various species of Hypna, not the drought resisting Grimmias and Polytricha that first covered the rocks. In the hollows and bogs the spongy peat moss absorbs and retains the water from melting snow and pouring shower to bless the scorching summer days with trickling rills and fragrant coolness.

The delicate green web of the alga-like moss protonema, springing from wind-sown one-celled spores, is one of the first signs of vegetation on soil bared by man or nature. This forms a protective covering over the crumbling soil, preventing the rushing waters of summer showers and spring floods from cutting deeply into the soil. In the mountain regions of North Carolina where the summer

PLATE III. Water loving *Hypnaceæ* on stones in a Vermont brook.

showers are torrential, I have seen square inches of moss protonema on top of small plateaus of soil, like a chip on a melting snowbank.

The beds of all our mountain brooks here in the East are covered with mosses which attach themselves to the stones and soil at low water and not only prevent erosion but catch and retain soil materials washed down from above, collecting a fresh layer of mud each season at the base of the ever elongating stems.

The freshness which a summer shower brings to the landscape is largely due to the unfolding of the mosses on tree and fence and boulder from patches of lifeless brown into soft cushions of living green.

The "Reindeer Moss" of the far North is a shrubby lichen with short hollow stems found not only in reindeer country but throughout the northern United States as well. The "Spanish Moss" of swampy regions of the Southern States is a flowering plant, an epiphyte, growing much like the tropical orchids.

The Hepaticæ, or liverworts, are most closely allied to the mosses and some species are difficult to distinguish from them. In general, however, the liverworts consist of a flat expanded body like a bright green lichen, or, if leafy, the leaves, which never have a midrib, are arranged in two rows on opposite sides of the stem and often in the same plane, giving the plant a flattened appearance unlike the great majority of mosses. In "fruit" the capsule of the leafy forms opens by four valves instead of by a lid as in the mosses (except *Andreaea*).

The terms used in describing mosses and hepatics are fully defined and illustrated in the glossary, and the student should make himself familiar with the principal terms as early in his study of the mosses as practicable.

The beginner in the study of mosses and hepatics should be content with the study of well-developed fruiting specimens. Sterile specimens should never be attempted unless their genus is readily recognizable from previous experience, or some marked peculiarity renders recognition easy. Imperfect or non-fruiting mosses often prove an insoluble puzzle to the advanced student and would be nothing but a source of discouragement to the beginner. Many mosses of the more difficult genera like *Hypnum* and *Bryum* are not included in this book because thay can not be recognized with any degree of certainty without the aid of the compound microscope. As some of these difficult species are common they will prove a source of annoyance to the beginner, and it is hoped will lead him to obtain, sooner or later, the necessary books and apparatus for a more extended study.

There are probably over a thousand species of mosses in the United States. Three hundred and eighty species and varieties are listed in The Moss Flora of New York City and vicinity. Only expert study with a well-stocked herbarium will enable a person to identify all these.

Almost any form of simple microscope will serve for the study of most of the mosses with this book, but to obtain the best results it should be of a construction suitable for carrying in the pocket into the field.

The hand-lens recommended for this book is of so short a focus that it can not readily be used for a dissecting lens, so that some form of dissecting microscope will prove very useful. If one can not afford a regular dissecting microscope costing from three to five dollars, a tripod costing less than one dollar will give good results. Place the object to be dissected on a piece of plain glass over white paper and stand the tripod on the glass.

For ordinary work a lens of from 8 to 15 diameters is needed, for the finer details a lens of 30 or more diameters is necessary. In studying very minute parts it will often be necessary to mount in water in the same manner as for the compound microscope. For the preparation of these slides the student should have half-a-dozen blank slides of glass, such as can be purchased of any dealer in optical goods, a small pair of fine flat-pointed forceps and two fine-pointed dissecting needles. A small scalpel is useful, but a good pocket knife will answer all purposes. Circles or squares of thin glass are useful, but two slides can be used with the object mounted in water between them. Mica can be used for covers or for slides and covers both.

In preparing these slides all specimens not fresh and moist should first be soaked out in hot water, the parts to be studied should then be carefully removed with the forceps and placed in a drop of water on one of the glass slides and covered with a cover circle or another slide. If one has a dissecting microscope with stand and mirror the slides can be studied in the usual manner, but almost as good results can be obtained by holding the slide up to a strong light and examining it thus as a transparent object.

Such characters as the gross structure of the peristome, the characters of the costa, and the margins of the leaves, position of the reproductive organs, and in many cases the general outline of the cells may often be satisfactorily made out.

The hand-lens can never equal the compound microscope for making out these finer details of structure, but the compound microscope is beyond the reach of many who would gladly study the mosses if it can be done with a hand-lens. No characters have been utilized in descriptions which the author has not been able to make out with his lens, but it may easily be true that the beginner may not be able to see so much at first.

Two blank slides, two rubber bands, a pair of fine-pointed forceps, and a small vial of water carried in the pocket into the field will enable one to mount slides on the spot and will often save the trouble of carrying home useless material or, what is worse yet, leaving a good thing behind because it is not recognized. The rubber bands are to slip over the two slides and keep them in place when objects are mounted between them.

To use a hand-lens with the best results the object or slide should be held with the thumb and fore finger of the left hand, and the lens with the right hand. Then by resting the right hand on the left, the lens can be focussed without difficulty. It is usually best to let the thumb of the right hand lie on that of the left. If the hands do not touch, it is very difficult to keep them steady enough to keep a high-power hand-lens in focus.

The only parts for the study of which the dissecting microscope is absolutely necessary are the antheridia and archegonia. These organs are readily found in acrocarpous mosses if not too badly decomposed by age, and after a little practice one will have little difficulty in distinguishing them with a high-power lens. In the pleurocarpous mosses they are often difficult to find. The best plan is to soak the plant thoroughly and place it on a large piece of glass, over white paper, and dissect off all promising buds. These are to be dissected separately in a drop of clean water on a slide, but they are so small and so often shrunken or partially decomposed as to make their recognition difficult.

In counting peristome teeth it is well to remember that the teeth are always in multiples of four, 4, 8, 16, 32, or 64, so that if a number more than one of these numbers is found one may know that the entire number is not less than the next higher.

Every one intending to study mosses will find a collection of dried specimens invaluable, and a collection is more easily made and cared for than of any other group of plants. The only reason for pressing specimens of mosses is that they may be stored satisfactorily in the herbarium. Each species has a distinctive look when naturally dried *in situ*, and the pressure should not be great enough to obliterate this. Note the difference between plants of Hedwigia dried under pressure and dried in the open, and you will easily see how important proper drying is for the student. My own practice is to place the mosses in an ordinary plant-press, put under medium pressure for twenty-four hours, and then remove and dry thoroughly in the open air. Mosses growing in thin mats are best spread out in the drying papers in their natural position, care being taken to remove any surplus of adherent substratum, soil, rotten wood, etc., also any other species that may be intertangled with the one it is desired to collect. If the mats are thick and consist principally of erect stems, it is better to break them up into vertical sections or slices before pressing. The substratum, the habitat, the locality, the date, and the name of the collector should be noted for each specimen, and either put in with the specimens or else recorded in a note-book, numbered to correspond to numbers attached to the specimens. The name of the person identifying the plant should also be written on the label. Many times it is also important to give the altitude at which the specimens were collected. The following is a good sample label:

NORTH AMERICAN MUSCI
Pseudoleskea rigescens (*Wils.*) ***Lindb.***
Bark of Alder Trees. Alt. 1,800 ft.
Beaver Meadows, Vancouver Id., Aug. 26, 1901.
Coll. J. W. Bailey. *Det. G. N. Best.*

When dried the mosses may be placed in suitable envelopes or pasted on cards, and preserved in an herbarium in the usual manner.

In the pronunciation of the scientific names it is well to remember that the best authorities give the English pronunciation of the Latin with the accent according to the rules of Latin grammar. The Roman pronunciation so much in vogue in schools and colleges is sure at some early date to supersede the English.

The pronunciation is indicated by the same signs as in the recent works on the flowering plants.

ˋIndicates the accent and the long, broad, open, or close English sound of the vowel.

ˊIndicates the accent and the short English sound.

Life-History and Structure of the Moss Plant.*

Perhaps the best point to begin the study of the life-history of the moss is with the spore, a minute, brownish, one-celled body produced in large numbers in the capsule of each fruiting moss plant. This, falling upon moist earth or other suitable substratum, germinates by sending out a slender, thread-like projection, which rapidly elongates and becomes much branched, but which remains a linear aggregate (i. e., it is made up of single, elongated cells attached end to end). This is known as the protonema and very closely resembles several species of algæ. Protonema may be obtained for study by sowing spores on moist soil or on unglazed pottery, treated after the manner described by Atkinson in his directions for obtaining fern prothallia.† In practice it is usually better to go to a greenhouse and gather some of the green filaments from the surface of the soil in those parts of the house that are kept most warm and moist. Young plants of *Funaria Physcomitrium Leptobryum* and occasionally other species will be found abundant.

Vaucheria (an alga) will probably be found more abundantly than moss protonema, but it is larger and is not divided up into cells by septa. There are one or two other species of algæ common in greenhouses, but if one takes the trouble to pull up young moss plants and study the protonema attached to them, he will soon learn to recognize the unattached protonema.††

If greenhouses are not readily accessible, a moist bank of bare earth, or the moist soil of a garden or cultivated field will usually furnish all that one will desire. In any case, look for very young plants, as protonema will usually be found attached to them. In this case a most interesting transition may be seen between protonema and rhizoid, one end of a filament being characteristic protonema, the other brownish, without chlorophyll, and divided by very few septa. Of course the rhizoid part was below the soil. After the protonema has reached a certain stage of development, an apical cell is produced, which forms a bud and young leaves and stem by a series of divisions in several planes.

There are some mosses that have very few leaves and rely upon a persistent protonema to do the work of leaves. Such a moss is *Pogonatum brevicaule*, which is frequent on clayey banks and by roadsides, where the soil has so recently been disturbed that other plants have not taken possession. Such a plant furnishes the very best opportunity for obtaining protonema, and, if dried specimens of this moss be soaked out, very satisfactory material can be obtained.

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* See Glossary for unexplained terms.

† Atkinson's "Biology of Ferns," page 106.

†† With a compound microscope.

A specially interesting point about mosses is that the cells are so little differentiated that a cell from almost any part of the plant may produce protonema under favorable conditions. Some mosses never produce spores, but when dry become very brittle and easily break up into minute portions which serve the purpose of spores. Many mosses go so far as to produce special bodies for asexual reproduction.

"The adventitious formations which serve to propagate asexually the moss plants are of two kinds,—bulbils, sometimes called gemmæ, and brood bodies, sometimes called propagula. In their simplest form, bulbils are little buds without apparent central axes, and usually appear on the stem, as in *Pohlia annotina*, but may be located on any part of the moss plant. When shed, sometimes even before, they produce rhizoids and grow directly into the vegetative plant. In their higher development, with rudimentary stems and leaves, they appear in bud-like aggregations on the ends of stems, as in *Leskea nervosa*, sometimes on branches as well. In their highest development, their character as shoots becomes apparent, with stems and leaves, as in *Dicranum flagellare*, growing into plants, however, in precisely the same manner as is done by the simplest forms.

"Brood bodies are polymorphous and variously located. In their simplest form they are deciduous rhizo-protonemata* which appear in clusters on stems, often on midveins, as in *Plagiothecium Roeseanum*. They are, however, usually more complex in structure, and are sometimes borne on specialized stems and branches, the pseudopodia, as in *Aulacomnium palustre;* or in a cup-shaped involucre, as in *Georgia pellucida;* or on rhizoids ("Brutknollen"), as in some of the *Barbulæ;* or on the excurrent costa, as in *Ulota phyllantha;* or on the paraphyses, as in *Pottia riparia;* or on the upper surface of leaves, as in *Tortula papillosa;* or on both surfaces, as in *Orthotrichum Lyellii;* or in fasciculate clusters on the midrib at the base of the leaves, as in *Grimmia torquata.* In whatever form or position they appear, their function is the same, the reproduction of the parent plant, which they accomplish by producing protonemata."†

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* Modified filaments of rhizoids or protonema.

† Dr. G. N. Best, in the January, 1901, "Bryologist."

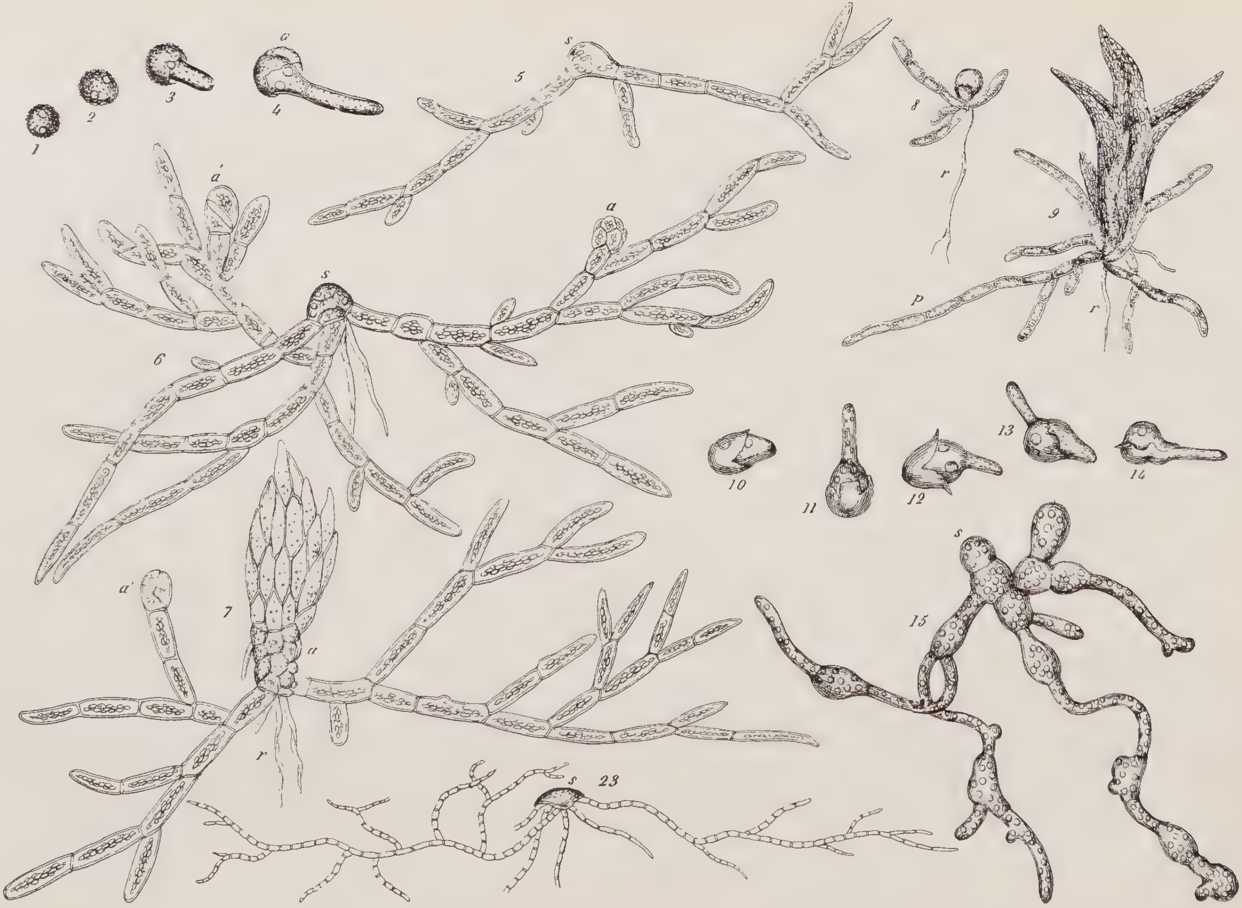
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PLATE IV. Explanation on next page.

Brood bodies are abundant on the rhizoids of Funaria in the greenhouses, and are easily obtained by pulling up the young plants and carefully washing off the adhering soil.

The leaves of mosses, as a rule, are but one cell in thickness, except at the midrib and occasionally around the margin. Many species with small leaves lack even the midrib. The thickened margin is usually found only in leaves of comparatively large size, like those of *Mnium* and *Bryum*, in which cases the thickened margin serves as an additional support. The cells of the midrib (costa) and the thickened margin are usually longer and narrower than the other cells in the same leaves.

For class use, several kinds of leaves should be obtained in order to show the variations in structure: *Mnium*, to show hexagonal cells, costa and thickened margin; some of the smaller *Hypna*, to show ecostate leaves; *Catharinea** or *Polytrichum*, to show the peculiar lamellæ rising from the upper side of the costa to furnish an additional surface for the absorption of light and water (these are best seen in cross-section but can be seen on a leaf mounted entire); the leaves of *Thuidium* or *Thelia*, to show the papillæ so common on many moss leaves; also leaves of *Dicranum*, *Rhacomitrium*, *Sphagnum* and *Fissidens*, to show their special peculiarities.

In determining species, the position and arrangement of the leaves are of great value. Unless otherwise stated, the leaves are arranged equally around the stem. In some cases they are distichous and complanate, but many species have the leaves complanate (i. e., arranged in one plane like the pinnæ of a fern frond); the leaves are really arranged in several rows but have become twisted around so as to lie in one plane, much after the manner of the Prickly Lettuce. *Plagiothecium* furnishes a good illustration of such a case.

Leaves which are turned to one side instead of standing straight out from the base are called secund, which is often used as a synonym for homomalous. Homomalous means that all the leaves are secund in one direction, as in *Hypnum uncinatum*.

EXPLANATION OF PLATE IV. (From Schimper, "Recherches sur les Mousses.")

1. Spore of *Funaria hygrometrica*, × 400. 2. The same after soaking two days in water. 3 and 4. Germinating spores of the same moss. 5. Protonema which has arisen from the spores of the same moss. 6. Protonema giving rise to apical cells and new axes of vegetation at *a* and *á*; *s* is the original spore, which seems to be dividing as if also to give rise to a plant. 7. A young plant at *a* and an apical cell at *á*. 8. Germinating spore of *Didymodon rubellus*. 9. A young plant of the same. 10, 11, 12, 13 and 14. Spores of *Orthotrichum leiocarpum* showing different stages of germination, × 500. 15. Protonema of the same.

* See Glossary under lamellæ.

The position and amount of concavity, or of folding, varies a great deal according to whether the plant is wet or dry. These characters are best observed with a strong hand-lens, with the leaves all in position and as near a normal condition as possible. Leaves selected for study should always be taken from the median portion of a stem or branch, as those at the apex and, more especially, those at the base are always very different in character from the typical leaves.

Many species of mosses bear on the stems among the leaves other structures known as paraphyllia. (See glossary.) These may be thread-like and simple or branched, fimbriate like the lip of an orchid, or like minute leaves. (See any species of *Thuidium.*)

The moss has no true roots, only rhizoids. It lacks also the vascular bundles so characteristic of the higher plants, but in many species the stem possesses a well-marked central strand of narrow elongated cells, which serve to carry water lengthwise through the stem. This central strand is usually correlated with the presence of a costa in the leaf, but there are some cases where one is present and the other lacking. In many cases the central strand is continued into the costa in the same manner that the vascular bundles of the higher plants are continued into the midribs of the leaves. The other tissues, shown under "central strand" in the glossary, are characteristic of all moss stems, although the outer layers are often reduced in number or in thickness of cell-wall.

The moss plant, as here described, is the gametophyte, or sexual generation, corresponding to the prothallial stage of the fern, and, like the fern prothallus, bearing archegonia and antheridia. (See glossary also.) These are usually borne in clusters, surrounded by leaves. The plants may be either monoicous or dioicous.

Explanation of Plate V. (Schimper, "Recherches.")

2. The male head of *Polytrichum juniperinum*, × 10. 3. Antheridia and paraphyses of the same, × 50. 4. The first beginnings of an antheridium of *Polytrichum formosum*, merely a single cell with chlorophyll grains, × 150. 5, 6 and 7 show successive stages in the development of the same. 10 shows the upper end of a nearly mature antheridium and a cross-section of the same. 9 shows an antheridium after the escape of its contents, 11 at the moment of the escape of the antherozoids. 12 shows a mass of antherozoids still in their cells, which are yet attached to each other as in the antheridium, × 400. 13, 14 and 15. Motile antherozoids in various positions, × 600. 16. Two of the same treated with iodine; the cell with its mucilaginous contents is contracted and attached to the spiral fiber. 23. Antheridium of *Sphagnum* before its rupture, × 150. 24. The same at the moment of the escape of antherozoids. 25. Antherozoid in its cell, as seen by Schimper. 26, 27, 28 and 29. Antherozoids free, as seen by Unger.

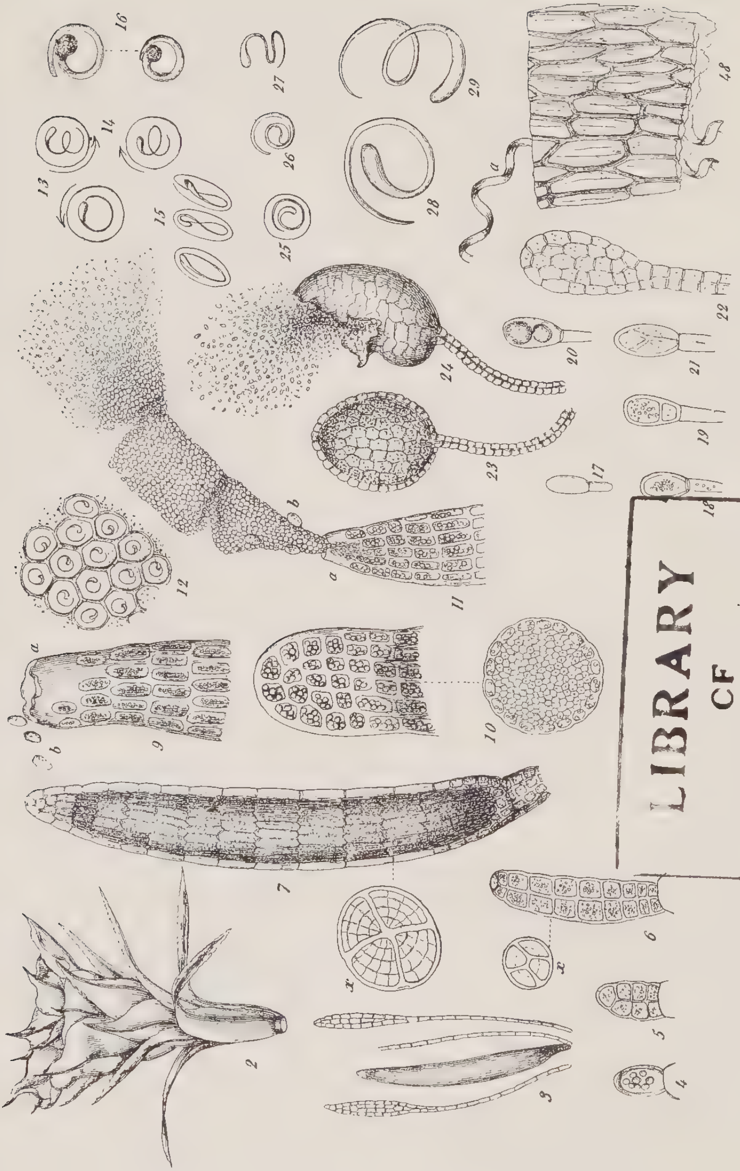
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PLATE V. (See explanation on preceding page.)

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In nearly all the mosses excepting *Sphagnum* and the PLEUROCARPI, the archegonia and usually the antheridia are borne at the ends of the stems. But in the PLEUROCARPI they are borne in axillary buds, or short branches, which are often called flowers, as are also the terminal clusters of reproductive organs in the other mosses.

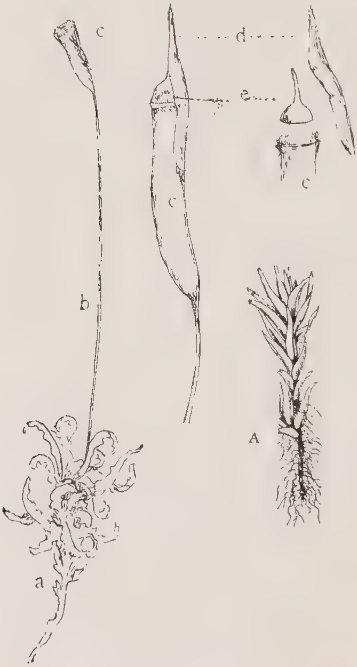

Fig. 1. General structure of a moss plant. *a*, stem and leaves; *b*, seta; *c*, capsule; *d*, calyptra; *e*, lid or operculum (of *Catharinea*). A, stem of *Barbula* with radicles at the bottom. Mosses have no true roots, only radicles or rhizoids, that are much like the root hairs of higher plants.

The egg-cell in the archegonium is fertilized by an antherozoid swimming in the dew or rain to the archegonium and down its neck, just as in the ferns.

After fertilization, the egg grows in a manner similar to that in the ferns, by absorbing nutrition from the gametophyte; but, unlike the fern, the sporophyte developed from this fertilized egg is almost entirely dependent on the gametophyte for its nutrition during its entire existence, and might almost be said to be parasitic upon it.

These actively swimming antherozoids are extremely interesting microscopical objects under the higher powers, 400 to 500 or more diameters, but I have always had difficulty in obtaining them in good condition. The time of fertilization of the different species of mosses varies, so that it would be possible to obtain the motile antherozoids at any season of the year if one could know just when to look for them. One must watch any given species with a great deal of care, or the first indication of the presence of the reproductive bodies will be the young "lances" of the sporophyte. The same species varies so, according to season and situation of the plant, that one can never depend on any given date for any species. The young sporophytes of *Polytrichum commune*, for instance, may appear at any time from November, in New York City, to May, in Vermont.

In order to get the best results, the plant should be collected a few days before the antheridia are ripe and kept moderately dry for a few days,—not dry enough to dry the plants completely; then, when the plants are put in water, the antherozoids will break out in swarms. This, of course, is a result of adaptation to the conditions of nature, for if the antheridia were to open in a dry time they would entirely fail of performing their function. I have had the best success with *Polytrichum juniperinum*. Collect a week or ten days after the snow has melted from over it and treat as directed above, and a fair degree of success is pretty sure to follow.

The sporophyte, when fully developed, consists of a slender, bristle-like stalk, the seta,* imbedded at its lower end in the tissues of the plant and bearing at its upper end the spore-case (sporangium, or capsule). Over the upper end of the capsule in young sporophytes is a little cap, or hood, the calyptra, which is formed of the upper part of the archegonium somewhat enlarged, and torn off from its base by the elongation of the infant sporophyte. The calyptra falls off easily at maturity and the capsule usually opens by a circular lid (operculum) which is easily detached from the lower portion of the capsule (urn) when the spores are fully ripe. The spores then escape through the opening thus made; their escape is not usually unrestricted, but is regulated by a fringe of fine teeth (the peristome) around the mouth of the urn. (Fig. 1.)

The life-history of the moss might be compared with that of the fern in a tabular manner, thus:

	MOSS	FERN
Gametophyte	spore	spore
	protonema	protonematal filament from the spore
	apical cell	apical cell
	buds which develop into the moss plant bearing archegonia and antheridia	prothallium bearing archegonia and antheridia
	egg-cell fertilized	egg-cell fertilized
Sporophyte	becomes oösperm	oösperm
	foot, seta and capsule	fern plant and sporangia
	spores	spores

The notable thing about this comparison is that in the moss the gametophyte is the lasting, nutrition-getting part of the plant, while in the fern it is the sporophyte which is the more permanent and obtains the most nutrition.

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* See Glossary.

The structure of the mature capsule is worthy of a little more careful attention. A longitudinal section through the middle of the capsule shows an outer or exothecial layer of thick-walled cells, inside this a few layers of thinner-walled parenchymatous tissue, then a layer of looser absorptive tissue, with very large intercellular spaces for the circulation of the air with carbon dioxide. Just inside this absorptive tissue, and separated from it by only one or two cells, is the archesporium, or spore-bearing layer, in which all the spores are produced, and in the center a mass or column of parenchymatous tissue, known as the columella, which extends beyond the spore-bearing layer into the cavity of the operculum. In some cases, the operculum remains permanently attached to the columella after dehiscence. In the (exothecial) outside wall of the neck or base of the capsule there are usually stomata which serve to admit air with CO_2 to the absorptive layers. The number of the stomata is very variable and the guard-cells are often confluent, so that the stoma appears to be surrounded by a single cell of the shape of an old-fashioned doughnut. The stomata may be either superficial or immersed, i. e., sunk in the wall of the capsule and partially covered by other exothecial cells. The position of the stomata in this respect is often of the greatest value in determining species, especially in *Orthotrichum*. (Pl. VI and glossary under *stomata*.)

The CO_2, taken in through these stomata and assimilated by the loose absorptive layer within, constitutes practically all the nutrition taken in directly by the sporophyte. The remainder of

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PLATE VI. (Schimper, "Recherches.")

11. Simple annulus of *Meesia longiseta*, × 150. 12. Portion of the same more highly magnified. 13. Part of the annulus of *Mnium hornum*, × 300. 14. The same seen in section, and a little more highly magnified. 15. Portion of the annulus of *Funaria hygrometrica*, seen from the internal face, × 300. 16. A single element seen from the side. 17. Portion of the epidermis of a young capsule of *Funaria hygrometrica* with a newly formed stoma, × 300. 18. A portion of the epidermis of the mature capsule of the same moss with several stomata. 19. A transverse section of a portion of the neck of a capsule of the same moss showing two stomata at *a*, *a*. 20. Vertical section of the same portion showing stoma in profile at *a*. 21. A stoma isolated from a portion of 18. 22. Portion of the epidermis from the base of a capsule of *Polytrichum commune* showing stomata of very different forms, × 300. 23. Vertical section with stomata at *a*, *a*, *a*. 24. Stoma of *Dawsonia polytrichoides* with a bit of the surrounding tissue. 25. Vertical section through the neck of *Lyellia crispa*. 26. Vertical section through stomata of *Dawsonia*.

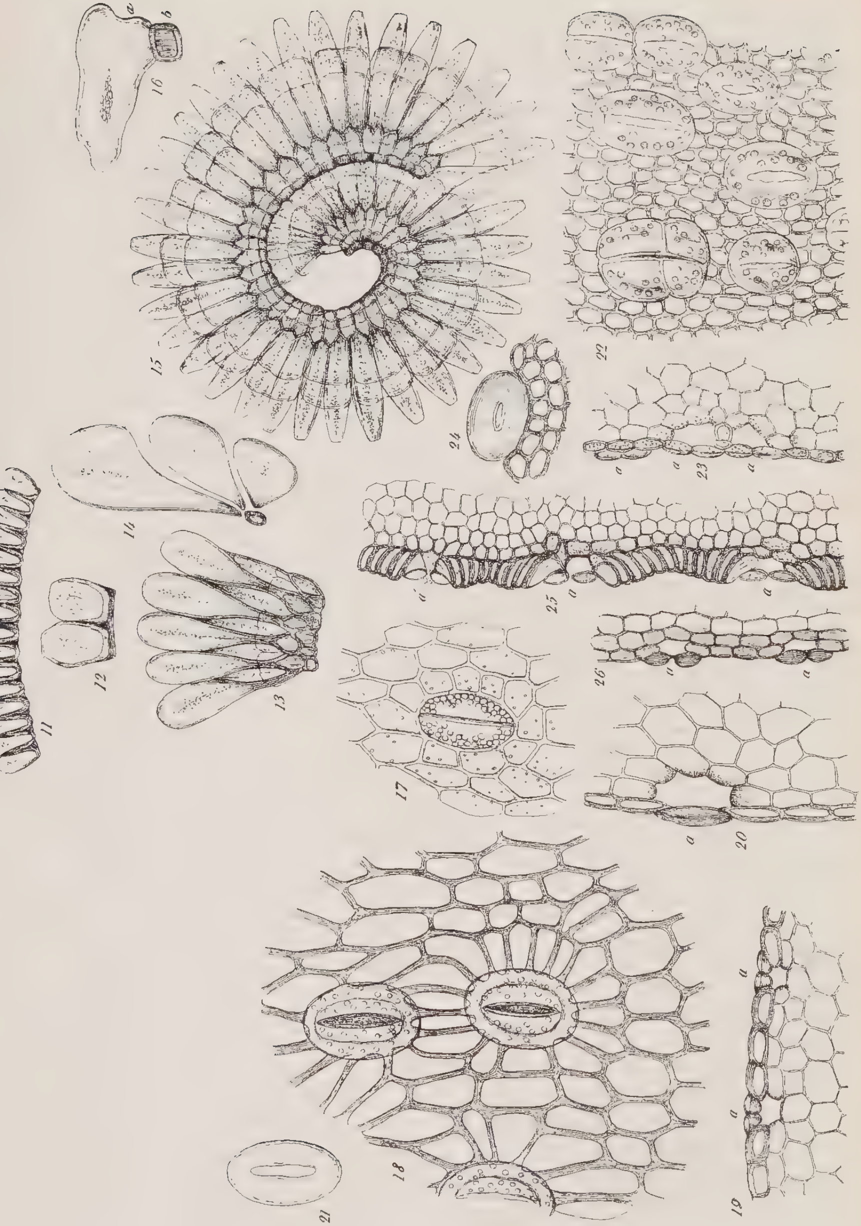

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PLATE VI. (See explanation on preceding page.)

its nutrition is taken in from the gametophyte through the base of the seta, though there is no more organic connection between gametophyte and sporophyte than between the placenta and uterus in the mammalia.

Between the edge of the urn and the operculum there is usually one or two rows of peculiarly elastic and hygroscopic cells, known as the annulus, which aids in the removal of the operculum when the spores are mature. The cells of the annulus are usually rounded, not angular, at their upper extremity, and their cavities are usually very small.

The peristome (see glossary) of mosses is one of the most beautiful and interesting structures of vegetable life. The teeth vary in number from four to sixty-four, always being some multiple of four. They are often most beautifully sculptured and colored, making microscopic objects of a great diversity of form and coloring. The markings, like those of the diatoms, are produced by differences in the thickening of the cell-walls. As the structure of the peristome has been found to give the most satisfactory indications of the relationships of mosses, and is, therefore, one of the most important factors to be considered in classification, it is of great importance to the student thoroughly to understand it.

The simplest type of peristome is that of *Georgia*, in which the tissue lying within the operculum divides almost equally into four sectors. In *Polytrichum* and its allies the teeth number thirty-two or sixty-four, and consist of elongated processes, triangular in cross-section, made up of long, hollow fibers formed by the absorption of the end walls of the cells which constituted the tissue in the earlier stages of its development. In both of these families the teeth consist of bundles of cellular tissue, and are without joints or external markings other than those caused by the outlines of the cells.

In almost all the other families of peristomate mosses the peristomes are not made up of cells but consist solely of cell-walls, on one or both faces of which there are engraved plates, or lamellæ, consisting of lignin deposited by the protoplasm which at first filled the cell cavities. The other walls of the cells, from which the peristomes are made, are absorbed before the maturing of the spores and the falling of the operculum.

For types of peristomes for general study *Georgia*, *Polytrichum*, *Webera sessilis*, *Dicranum* (see glossary under bifid) and *Dicranella* or *Fissidens*, *Barbula*, *Grimmia*, *Orthotrichum*, *Funaria*, *Mnium* or

Bryum, *Hypnum* (see glossary under cilia), *Leskea* and *Fontinalis* are recommended. These are common forms.

If one is curious to pursue the matter farther, *Buxbaumia indusiata*, *Cinclidium* and *Dawsonia* are recommended.

It has long been recognized that moss peristomes are strongly hygroscopic, i. e., respond by active motions to any changes in the amount of moisture in their tissues. It has also been recognized in a general way that the peristome played some part in the distribution of the spores, and that its hygroscopic activity aids in this work; but very little attention seems to have been paid to the details or to the extreme nicety with which the peristome in different species has been adapted to do its work.

The spores of mosses must depend largely upon currents of air for distribution, hence they must be securely protected from rain or dew, which would mass and clot them together so that they would fall directly to the ground as soon as liberated, to say nothing of the danger of premature germination and decay.

Then, again, the spores must be liberated in small quantities, so that they will not all be discharged at once but take advantage of breezes from different directions and be sown at various seasons. They must also be well separated or sifted, so as to be as widely separated as possible when they finally alight. This sifting of the spores is accomplished by various interesting devices which are specially prominent in mosses with pendent or horizontal capsules. In mosses with a double peristome the inner peristome is usually the sieve, while the outer protects from water by closing hygroscopically in wet weather. In mosses with a single peristome both functions are often performed in a very interesting manner by the single row of teeth.

In mosses with upright capsules there is less need of a so finely meshed sieve, as the spores will not fall out but will be shaken out after the manner of lily seeds. To assist in this shaking, the seta is often almost as elastic when dry as a steel wire, and if bent to one side flies back with a jerk when released, which scatters a small cloud of spores. In wet weather not only do the peristomes close, much after the manner of chickweed pods, but the seta becomes soft and flaccid. As the highest development of this sifting arrangement is of no special advantage to mosses with an erect capsule, the inner peristome has become more or less vestigial in those mosses which have erect capsules, although they may be most closely related to species having cernuous or pendent capsules with a highly developed inner peristome. Philibert, in his masterly treatment of the structure of the peristome, calls attention to this correlation of symmetric erect capsule with a degenerate peristome, but gave no explanation for the very evident facts. In this connection he mentions *Anomodon viticulosus*, *Habrodon Notarisii* and *Pylaisia polyantha*, calling attention not so much to the inner peristome as to the disappearance of the fine horizontal lines which mark the lower outer lamellæ of the typical hypnaceous peristome. Most striking illustrations of the correlation of the erect capsule with an imperfectly developed inner peristome are furnished by *Brachythecium acuminatum* and its allies, by *Plagiothecium latebricola*, and the genera *Pylaisia*, *Entodon*, *Orthothecium*, *Isothecium* and *Homalothecium*. This also explains why *Thuidium* and its allies have a perfectly developed inner peristome, while most of the *Leskeaceæ*, having erect capsules, have also imperfectly developed peristomes. I am inclined to think that this principle, modified by an annual habit of growth, or a very low minute growth, or both, will explain the lack, partial or complete, of a peristome in *Physcomitrium*, *Pottia*, *Pleuridium*, *Weisia viridula*, and other species of a similar habit and structure. It will also explain the degenerate condition of the peristome in *Orthotrichum* and its allies. However, it seems very probable that we do not yet fully understand why mosses like *Pleuridium* do not seek the assistance of a peristome in their spore distribution, and I would suggest that this question offers a fascinating field for investigation.

An apparent exception to the perfect development of the inner

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PLATE VII.

1. Moist peristome of *Polytrichum ohioense* R. & C. 2. The same dry. 3. Dry peristome of *Georgia*. 4. The same wet. 5. Four teeth of the peristome of *Catharinea undulata* (L.) Web. & Mohr. 8. Dry peristome of *Barbula amplexa* Lesq. 7. A perfect peristome of the same moistened. 6. An older peristome of the same moistened. 6, 7, and 8 represent different positions of the peristome of *Barbula amplexa* Lesq.[*] 7 shows the peristome immediately after the removal of the operculum. 8 shows the appearance of the operculum of a dry capsule from which the spores are escaping. The loosely twisted mesh of the narrow teeth forms a perfect sieve to control the escape of the spores. If you place a peristome in this condition under the microscope without mounting medium or cover-glass and breathe upon it the teeth will straighten perceptibly. If you dip it in warm water it will assume the original position shown in 7, if it be comparatively fresh; if it be rather old and somewhat broken it may look like 6. The perfect cone in 7 is, of course, a waterproof covering for the spores inside.

[*] As the peristomes were drawn by reflected light, the basal membrane was scarcely noticeable.

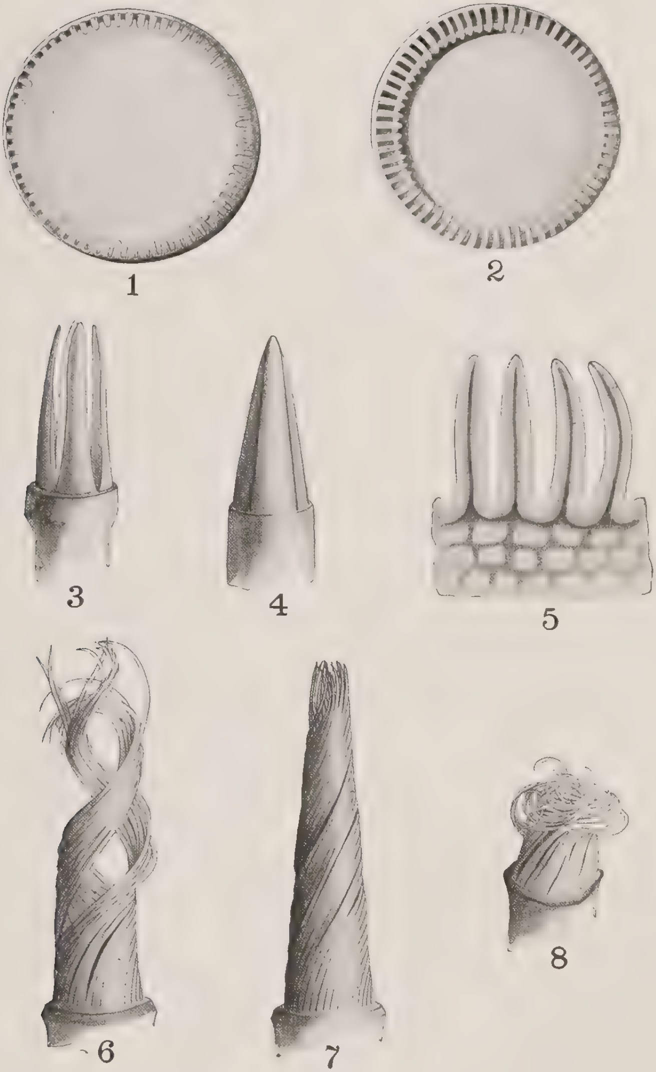

Plate VII. (See explanation on preceding page.)

peristome in plants with pendent capsules is found in some species of *Pohlia*, notably *P. acuminata* Hornsch. The lack of cilia may possibly be explained by the very slender capsule with narrow mouth —structural characters which would tend to retard the escape of the spores.

Another peculiar and interesting fact is the similarity of capsule form and peristome structure in mosses that grow on trees, even though they belong to widely different groups and families. Such mosses nearly always have ovoid symmetric capsules and the inner peristome much less highly developed than in closely related forms having a different habitat. Compare in this respect *Orthotrichum*, *Pylaisia*, *Homalotheciella subcapillata*, *Leskea*, *Thelia*, *Anomodon*, *Leucodon* and *Neckera*. This, of course, does not apply to mosses growing at the base of trees, but only to those that are truly trunk-growing species.

In *Georgia* the capsules are erect, and its four teeth well separated when dry, as seen in Plate VII, fig. 3. Dip one of the dry capsules in warm water for a moment and see the peristome close like a tiny vise, giving an almost comical impression of grim determination. Plate VII, fig. 4.

In *Polytrichum* the teeth are sixty-four in number, and of themselves are usually so short that they would have little effect on spore distribution, but they are all attached, by their tips, to the expanded membranous upper end of the columella, forming a most effective and ingenious pepper-box, entirely automatic in action. When the weather is dry, the teeth become shrunken in width, and strongly incurved; the columella also shrinks, pulling the ends of the teeth inwards (Plate VII, fig. 2). This leaves ample room for the spores to be shaken through the openings between the teeth. The columella shrinks more at the margin than in the central portion, causing it to assume the shape of a pie-plate. This upturned margin of the columella also enables the teeth to remain attached to its edge in their changed position. In species of this family with more nearly erect capsules the teeth are longer and often fewer in number, making the escape of the spores easier.

If you take a capsule in the condition represented in Pl. VII, fig. 2, and place it in warm water for a few minutes, it will assume the appearance shown in 1, and no spore can be shaken out; although a careful examination of the contents of the capsule will show that the spores are not wetted, as when mounted in water they are still surrounded by an envelope of air.

The pepper-box is closed, but how? Kerner von Marilaun* states that the teeth, when wet, curve inwards so strongly that the columella is pressed against the mouth of the capsule, closing it effectually. Five minutes' study, however, will show any one that the teeth do not curve in when wet, but, instead, straighten up and outwards; the columella also expands and becomes of nearly the same diameter as the capsule. This makes the openings lateral instead of terminal. The teeth expand enough laterally so that not a single drop of water can enter or a spore escape. In addition, the spores seem to be protected by the nature of their outer surface, for it takes a very long soaking to wet them so that they can be satisfactorily mounted in water for microscopic study.

Pl. VIII, fig. 2, shows the peristome of *Hypnum* in its dry state. Note how the cilia fill the spaces between the segments, forming a perfect sieve. 1 shows the same peristome wet and closed so tightly that no water can get in or spores get out. One can easily see from an examination of these two figures the advantage of having the segments alternate with the teeth.

This illustration is from a *Hypnum* with a strongly curved capsule. If an illustration were chosen from a species with an erect capsule the cilia would, in most cases, be more or less rudimentary and the segments narrowed, as is explained in the beginning of this topic.

In the same figure, 4, the dry peristome of *Ceratodon purpureus* is shown. The loosely incurved teeth form a capital sieve. 3 shows the same dry. The peristome of *Dicranum*, shown in 5, 6, and 7, is very similar to that of *Ceratodon*, only the teeth are broader and less incurved when dry.

In *Fontinalis*, which is always submerged, the peristome consists of a net-work, through the meshes of which the spores gradually escape. In *Cinclidium* the inner peristome is a dome-like structure with apertures near the base, which are opened and closed by the hygroscopic teeth of the outer peristome.

A peculiar peristome of much the same structure, but from a moss of an entirely different family, is found in the European moss, *Orthotrichum callistomum* Fisch. These last two are so curious yet so beautifully adapted for their work that it seems almost like a fairy tale, and would be scarcely credible if told of some rare unknown tropical plant instead of having been seen and described

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*Nat. Hist. Plants, **2**: 814.

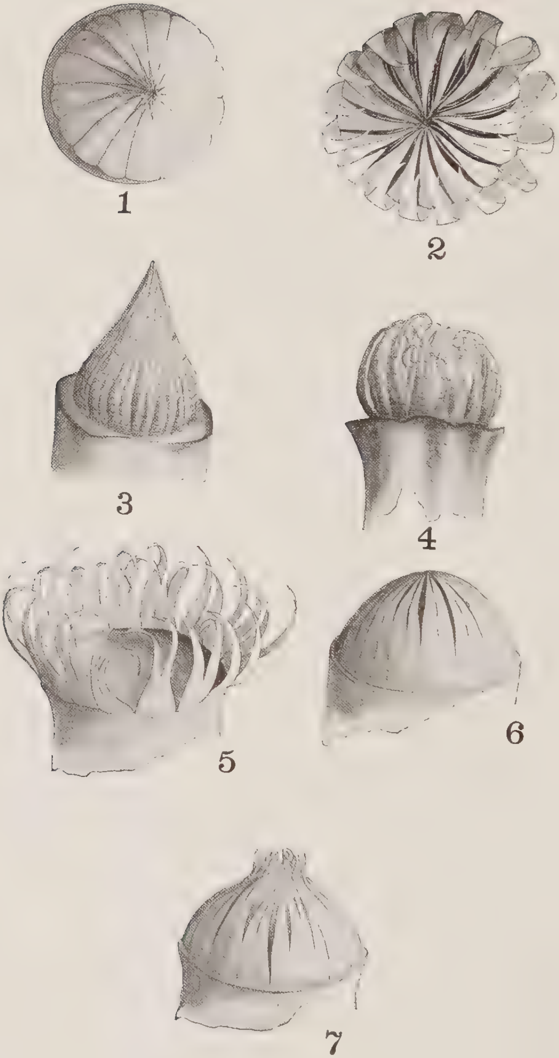

PLATE VIII.

1. Peristome of *Hypnum*, moist. 2. The same dry. 3. The peristome of *Ceratodon purpureus*, moist. 4. The same dry. 5. A dry peristome of *Dicranum*. 7. The same moist. 6. The peristome of a *Dicranum* from which the operculum had just been removed.

by several of the most matter-of-fact botanists. A somewhat similar arrangement is found in *Cinclidium stygium.*

Professor Karl Goebel, of the University of Munich, in his "Organography of Plants" has made a classification of moss peristomes according to their adaptations for spore distribution. The following is abbreviated from his work:

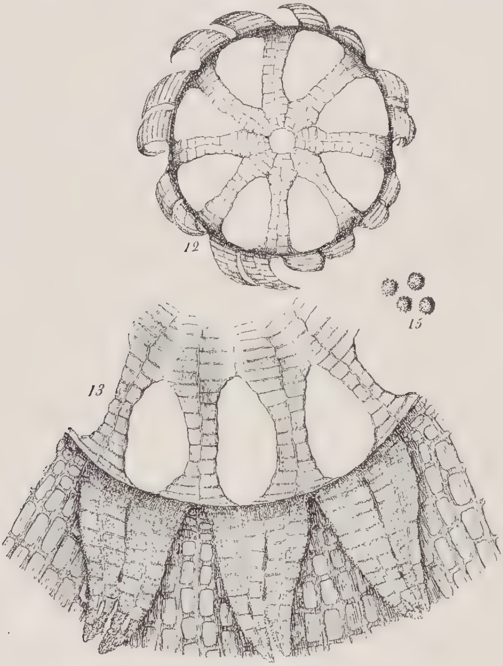

FIGURE a.

Peristome of *Orthotrichum callistomum* (Bry. Eur.).

1. Mosses with a single peristome that is reflexed when dry but when moist serves to close the mouth of the capsule, e. g., the *Weisieæ* in the *Tortulaceæ.*

2. Single peristomes that twist up and form a sieve when dry but close the opening when moist, e. g., *Ceratodon, Dicranum.*

3. Double peristomes in which the outer is reflexed when dry and the inner acts as a retainer of the spores, or rather a sieve.

Under this class he names several types: *Orthotrichum, Funaria, Conostomum, Hypnaceæ, Fontinalis.*

4. In this class the columella acts as a stopper. It may remain attached to the operculum, which then closes the opening by the swelling of the capsule in moist weather, or it may partially plug the opening as in *Pottia*, or it may become expanded at the end into an epiphragm attached to the teeth as in *Polytrichum.*

FAMILY 1. SPHAGNACEÆ. The Peat Mosses.

The Peat Mosses (Pl. IX) are so different from the other mosses that many bryologists do not consider them as mosses at all, but would put them in a separate class. Their protonema is much like the prothallium of a fern, and the stalk upon which the capsule is borne is not at all homologous with the seta of the other mosses, as it is an out-growth from the gametophyte and not the lower portion of the sporophyte, i. e., it is developed from the moss plant instead of from the fertilized egg-cell. The structure of the leaves is also very different from that of the other mosses. The leaves of some species are pink or deep red and furnish microscopic mounts of very great beauty.

Although the *Sphagnaceæ* consists of but one genus, the number of species is very large and the distinctions are very puzzling, so that only two or three of the commonest and most easily recognized species are here discussed.

Economically, the Peat Mosses are of more value than any others.

Besides its service in soil and climate conservation, Sphagnum or Peat Moss is useful far above all others. By its rapid and limitless growth it fills in hollows, bogs and even small lakes. Into such places all sorts of vegetable debris is washed and blown until vast beds of peat are formed. The value of peat for fuel is known but little appreciated in this country. A recent writer says: "New Jersey has enough to last a century.—Chicago has beds of the richest gas-fuel almost within the city limits.—New York City has dug out and thrown into the bay from its own subsoil peat enough to keep its fires going all this winter.—Consumption is practically unknown in peat-burning districts." Before the war peat briquettes could be made for sixty cents a ton and they have half the heating value of the best coal.

"Peat is the deposit of dead swamp moss and other bog plants charged with carbon, often with bitumen. The swamp moss, one of the most enduring plants known, will hold two hundred times its own weight of water, and its earth holds eighty to ninety per cent. Dry the sods in air and they burn so well that a ton and four-fifths equals a ton of coal for heating purposes. That is to say, it has about half the heating power of good coal and more than twice the heat of wood. If a measureless supply of wood existed within two hours of the city, to be had for cutting and hauling, we should feel easy on the fire question. Years since a careful State geologist estimated the peat along the Hudson River through Westchester and Rockland Counties at over two million cords, with better yield in the interior of those counties. The subway cuttings come upon it every little while, and the Irish workmen carry home sods of it to burn for the sake of the old country. The writer took a turf up town from the cuttings at the Tombs Power Station and it made incense in a bedroom grate for days. It was not dry, yet it burned and gave heat. But what was most curious and delightful was its aroma, like that of pines in the noonday sun. Its soft, purifying effect on the air, due to its moist, antiseptic property, soothed irritable lungs and made breathing easy. Enough had been read and heard of the "glowing fires of peat," but the charm of its subtle odor and the soft purity of its air were a novelty."

The average heat given by the best soft coal is 13,600 thermal units per pound, that of dried peat 9400 units. But there is such a thing as prepared peat, ground to pulp like wood fibre for paper, the water extracted by ventilator fans, and the pulp pressed into blocks three by four inches, hard as coal and clean as tile, yielding more heat than ordinary hard coal.

"Sweden outdoes the world in fuel enterprise, for not only are its briquettes the best made, but its Royal Peat Association last year, which showed twenty-four varieties of native peat, besides briquettes from Russia, Germany, and Holland, and the turf grown by the Peat Cultivation Society. Peat can be grown from Sphagnum and Hypnum swamp mosses in twenty-four years, although the vast deposits existing in the world began when mammoths had the globe to themselves. The exposition also showed quantities of by-products from peat, which equaled in variety the derivatives from coal—paraffine, acetic acid, peat spirit, peat tar, and ammonia in the list. It is not out of the way to consider peat as an unfinished coal, mixed more or less with petroleum, the villainous smell left out. According to master engineers, two million tons of prepared peat have been used yearly in Swedish works."

Few regions north of the Carolinas are without a plentiful peat supply within a radius of fifty miles, and where this is the case it is cheap and beneficial to use common air-dried peat for household fires.

In many portions of Ireland and Scotland peat is almost the only fuel supply of the peasantry. In the United States there is an abundant supply of peat. Dana estimated that there are 15,000,000,000 cubic feet in Massachusetts alone. Cheaper and more satisfactory fuels are so abundant that peat is little used in this country.

The memorable coal strike of 1902–03 called attention to our enormous and easily accessible supply of fuel of this sort, and some attempts were made to utilize this source of fuel supply. During the civil war, when coal was scarce and high-priced, peat was used to a considerable extent, and if coal should again become scarce and high-priced for any considerable time there is no doubt that the peat supply of our country could be made to furnish fuel for its needs for a century or more. At present it is not likely to compete with coal, because people are unfamiliar with its use, and the demand has not warranted any great investment in plants for scientifically preparing it for market. Those interested in the matter should read the article (quoted above) by Mr. S. Power, in the "Outlook" for January 17, 1903.

*"Until quite recently, sphagnum has not been generally considered as possessing any particular economic value, except in connection with the formation of peat, where its importance is well recognized. To be sure, it is used quite extensively by florists and nurserymen as packing material for plants, and locally it is employed for stable litter and bedding, as well as for various other purposes. But its value in surgical work, while recognized many years ago in Germany, has been little appreciated outside of that country, and it is only recently that this phase has come into prominence."

"For use in absorbent pads, the sphagnum is not merely equal to absorbent cotton—it is superior to it. According to Professor Porter,† sphagnum pads surpass cotton pads in the following important particulars: (1) they absorb liquids much more rapidly: about three times as fast; (2) they take up liquids in much greater amounts: a cotton pad will absorb only five or six times its weight of water, as compared with sixteen, eighteen, and even as high as twenty-two times, for a sphagnum pad; (3) they retain liquids much better: which means, of course, that the dressings need be changed less frequently; (4) they distribute the absorbed liquids more uniformly throughout their mass; (5) they are cooler and less irritating, yet at the same time fully as soft; (6) they can be produced at much less expense."

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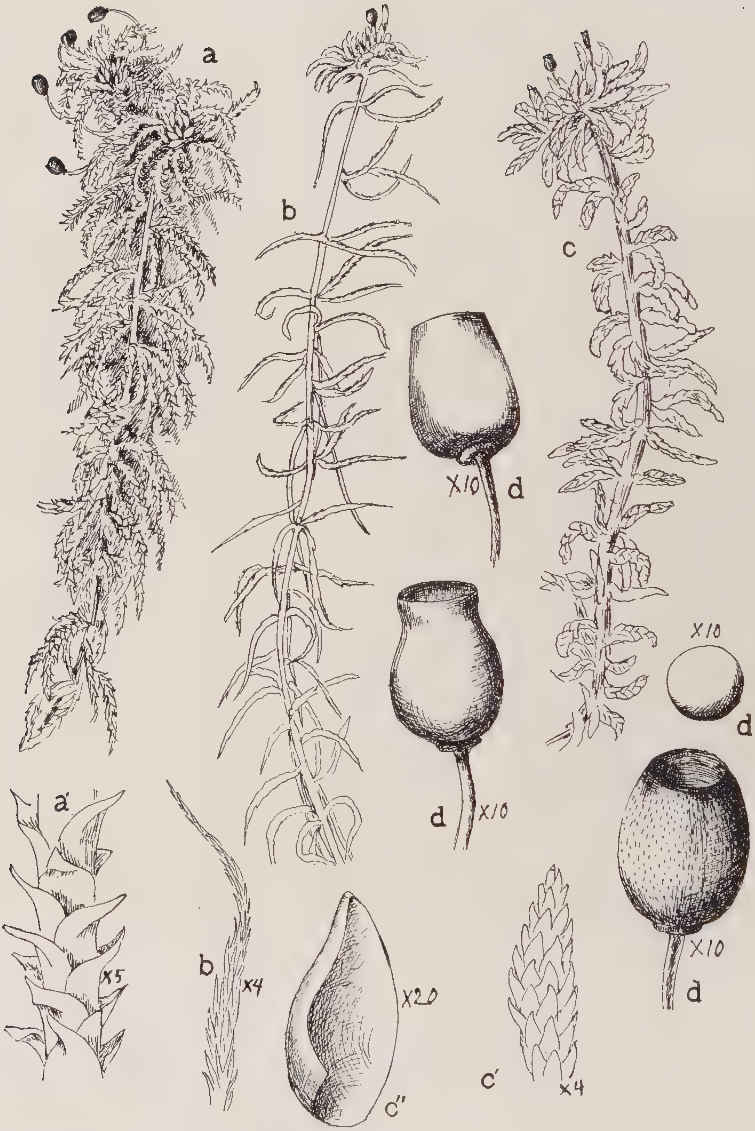
* G. E. Nichols in The Bryologist, Vol. XXI, No. 4, July, 1918.

† Porter, J. B. Sphagnum surgical dressings. Internat. Journ. Surgery **30**: 129–135. *f. 1–8.* 1917. Distributed as a separate by the Canadian Red Cross.

"The structural peculiarities of the sphagnum plant, which enable it to take up and retain liquids, are, of course, familiar to all moss students and require only brief comment. Suffice it to say that whereas in a cotton pad liquids for the most part are merely held within a tangle of threads, in the sphagnum we have a highly efficient absorbing system. The ability of the sphagnum in this respect can be attributed to three features: (1) the presence of the large, colorless, porous cells in the leaves and frequently also in the stem and branches; (2) the close overlapping of the leaves on the branches; (3) the sponge-like matting of the pendent branches around the stem."

"There is a great difference in different lots of sphagnum when it comes to the selection of material for use in surgical dressings. First of all, different species differ greatly in their capacity for absorption, degree of softness, etc. Thus, of the forty species of sphagnum native to North America, only those belonging to the *Inophloea* group (the group which includes *S. papillosum*, *S. palustre*, *S. imbricatum*, *S. magellanicum*, etc.) have been found wholly satisfactory. Species of the *Compactum* group (*S. compactum*, *S. strictum*) have not been tried out, but ought to furnish excellent material. *S. squarrosum* seems excellent as to foliage and probably is open to objection only on account of its usually wiry stem. The species in the remaining groups, comprising about three-quarters of our native sphagnum flora, are virtually useless for surgical purposes, although some of them may be employed to a limited extent for special purposes or in combination with material of the more suitable species."

"Speaking in general, it can be said that the more robust species of sphagnum are superior to the more delicate; forms with large leaves, dense foliage and close-set branches are greatly preferable to those with small leaves, skimpy foliage and scattered branches. Harsh, stiff, or brittle forms must be avoided. In this connection it should be further pointed out that not only is there a wide range of variation in the suitability of different species of sphagnum for


a
b
c
X10
d
X10
d
d
X10
a'
X5
b
x4
X20
c''
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x4
X10
d

PLATE IX.

a. Sphagnum squarrosum Pers. *b. S. capillaceum* (Weiss) Schrank. *c. S. palustre* (L.) Hedw. *d.* Capsules of *Sphagnum.*

surgical use, but in that of the same species from different regions or from different habitats within the same region. Thus, the average quality of material from the humid districts of western Washington and Vancouver is much higher than anything that has been seen from the East. In grading his western material, Professor Hotson regards *S. imbricatum* as the most desirable species for surgical work, with *S. palustre* second, and *S. papillosum* third. In the East the order of excellence appears to be exactly reversed, *S. papillosum* being regarded as by far the best species (see Porter, *l. c.*). Further,

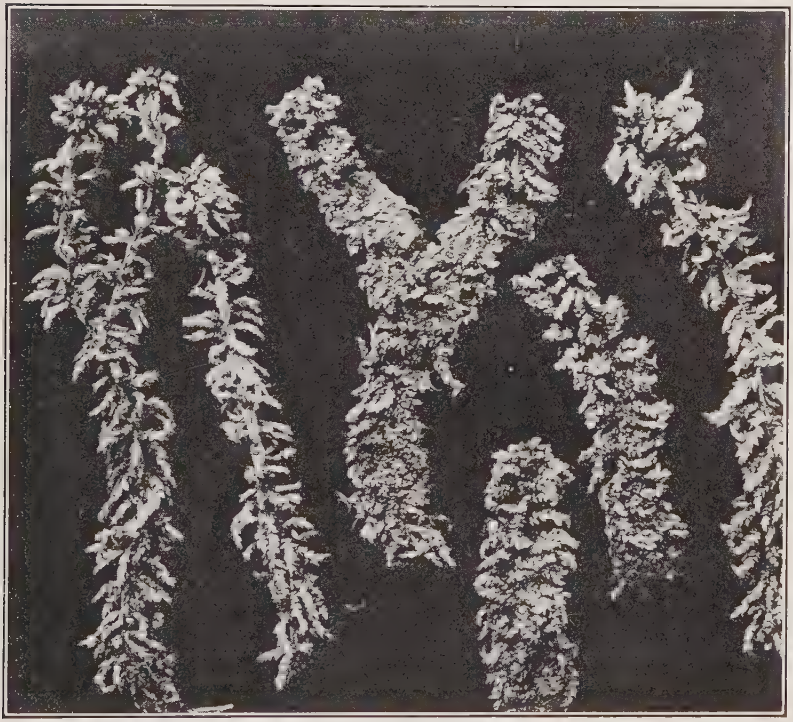


FIGURE 2.—Sphagnum of Surgical Quality (*S. papillosum*). Photo by G. E. Nichols. The specimens shown at the centre are the best. From House and Garden Magazine.

the sphagnums attain their optimum growth in bogs, and, when present, the best qualities of surgical sphagnum almost invariably frequent the wettest parts of a bog. This is true even in the humid Northeast, but it is even more so in regions where climatic conditions are less congenial. The same species (e. g., *S. papillosum*) may grow throughout a bog, yet it may attain the requisite degree of luxuriance only in the wettest, quakiest parts of the bog; elsewhere, not only will it be poor in quality, but the chances are that it will be more or less intimately mixed with undesirable species. In searching for surgical sphagnum, it is a good rule to avoid wooded swamps, for while sphagnums usually are present in abundance in

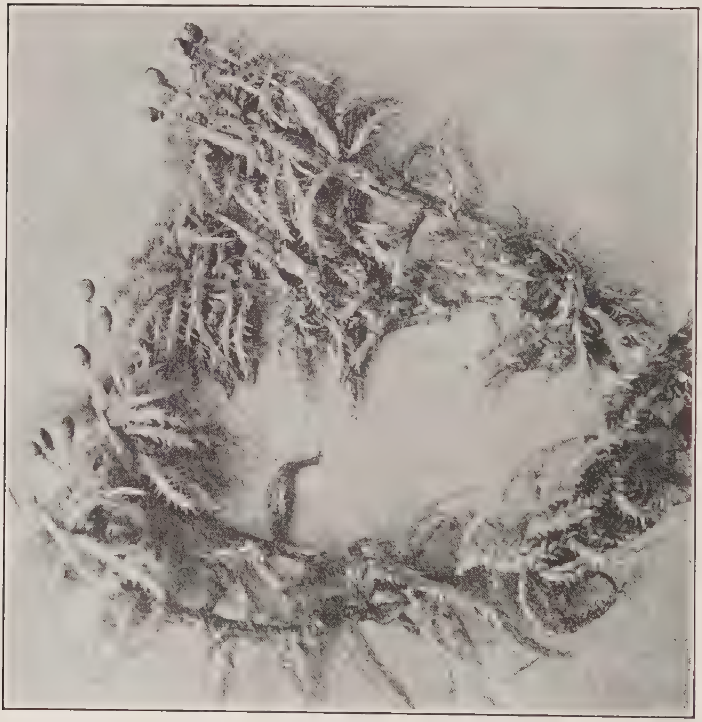


FIGURE 3.—*S. squarrosum* Pers.

such places, for various reasons the material generally is of too poor quality to be of surgical value. Bogs which are densely populated by heaths or other bushy growth likewise furnish unfavorable conditions, except locally, where there are wet, open depressions."

Peat mosses grow into small ponds from the margin and frequently fill them entirely, forming quaking bogs. In other instances there is a small black pool in the centre of the bog—all that remains of a much larger body of water that once occupied the whole area now occupied by the bog.

These bogs are very treacherous, and men and animals not infrequently perish through being engulfed in the black slimy mud. There is some antiseptic property in this mud which preserves animal and vegetable tissue for a long time. Huge logs are often dug out of these swamps in a condition fit for excellent lumber. In Ireland, the body of a woman dressed in hair-cloth was unearthed from under eleven feet of peat, where it must have lain for centuries.

Peat mosses absorb water very freely and serve to hold back the water that falls during heavy storms, preventing floods and retaining the water until it is more needed. Because of this absorbent power these mosses are much used by florists for packing flowers and by stable-men for bedding.

Peat mosses are dried and baled like hay and sent to the cities in great quantity for use in stables instead of straw. The moss absorbs liquids and gases so freely that stables using it are almost free from odor.

These mosses are easily recognized by their light gray-green color (sometimes pink or red at the top) and their peculiar shape, which is well illustrated in the figures.

Professor Goebel, in his Organography of Plants, gives an interesting account of the method of spore dispersal in Sphagnum. According to him, the ripening capsule absorbs air, and when fully ripe the sun's rays dry out the moisture, causing the capsule to shrink in all directions, but a great deal more transversely than longitudinally. This gradually compresses the air until the lid of the capsule is forced off with an explosion that has thrown the spores as far as four inches.

Although Professor Goebel did not mention it, it seems to me that this explosion is very probably "touched off" by passing animals or even by sudden breezes, so that the spores will find a ready means of dispersal. Certain it is that the spores will escape in dry weather, which is most favorable for wide dispersion.

The Peat mosses of Europe and America are the same in the main. There are, according to recent continental authors, a great number of species, which it requires all the trained ability of an expert to recognize. But for our purposes there are two easily recognized groups, each of which contains many so-called species.

The Spoon-leaved Peat Mosses, Pl. IX, *c*, *c'*, *c''*, are easily recognized by their thick branches and their broad spoon-shaped leaves. The Acute-leaved Peat Mosses are figured in *a*, *a'*, and *b*, *b*. Figure *b* represents the Acute-leaved Peat Moss, which is common in all the peat bogs of Europe and America. It is often tinged at the top with a bright red or crimson color. The Squarrose Peat Moss is one of the acute-leaved group, but is easily distinguished by the spreading tips of the leaves, as is indicated in Figs. *a*, *a'*, and Pl. IX. The branches are much stouter than in the Acute-leaved Peat Moss.

Figure 4 shows *S. Girgensohnii*, a species which looks much like the Acute-leaved Peat Moss, but is easily distinguished with high power, as the tips of the stem leaves are fimbriate-lacerate, that is, torn into a sort of fringe.

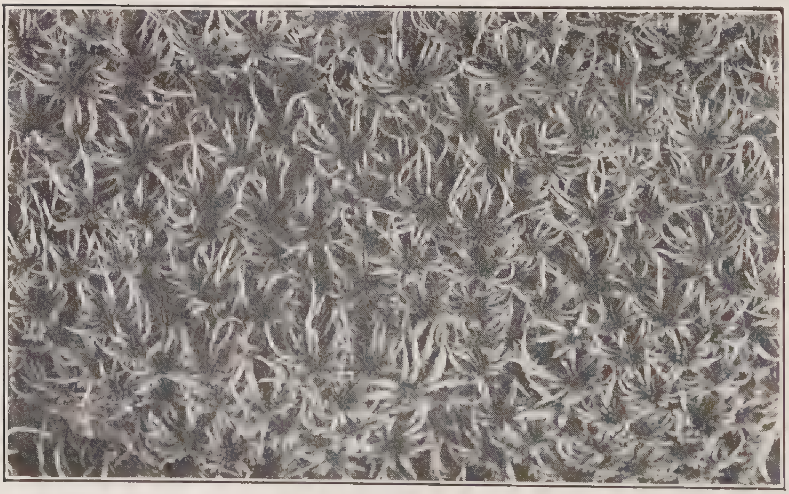


FIGURE 4.

FAMILY 2. ANDREAEACEÆ. The Andreaëa Family.

This family is characterized chiefly by the dehiscence of the capsule, which splits into four valves after the manner of the Hepaticæ, the valves remaining attached at the apex. The plants of this family are all mosses of alpine or subalpine habitat, growing upon granitic or slaty rocks. The appearance is always dark, sometimes black, and the leaves are very brittle and dense. The presence of chlorophyll in the leaves is not apparent except in very young leaves. There is very little difference in the capsules of the different species.

Andreaea petrophila Ehrh. is common on exposed rocks in the mountains of our range. It is easily distinguished from any species of Grimmia or Orthotrichum by its lack of costa, and it is much more slender than Hedwigia, and without hyaline points to the leaves. The other points in its structure are best made out from the illustration. It is abundant on the face of the Old Man of the Mountain in Franconia Notch, N. H.

A. Rothii W. & M. (*A. rupestris* of many authors) occurs with the preceding and occasionally descends to lower levels on exposed rocks. It has been found along the Hudson, at Yonkers. It is easily distinguish-

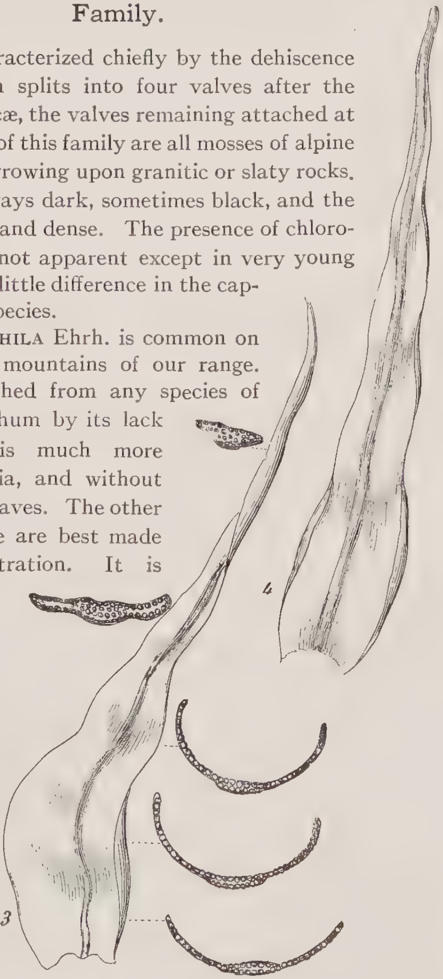


FIGURE 5. *Andreaea Rothii* (From Bry. Eur.). Leaves and leaf sections.

ed from *A. petrophila* by the elongate-lanceolate leaves and the strong costa reaching to the apex of the leaf, or beyond.

The last species, if sterile, will be with difficulty distinguished from Grimmia, by one not familiar with it, unless comparison with authentic specimens is possible. The time of maturing spores seems to be spring in each of the species. In *A. petrophila* they mature in May and June.

FAMILY 3. GEORGIACEAE. The Georgia Family.

All of our mosses belonging to this family are distinct in the four-parted peristome, each of the four teeth being composed of a solid mass of cellular tissue. The leaves are ovate to lanceolate, costate, leaf-cells rounded-hexagonal.

GEÓRGIA.

The botanists of preceding centuries were often under royal patronage and frequently found it convenient to pay their respects to kings and queens. Thus, Georgia is named for King George III of England, and Catharinea for Empress Catharine II of Russia.

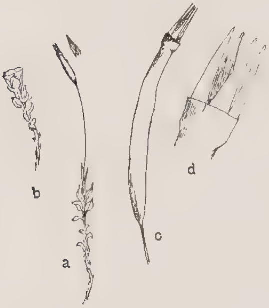
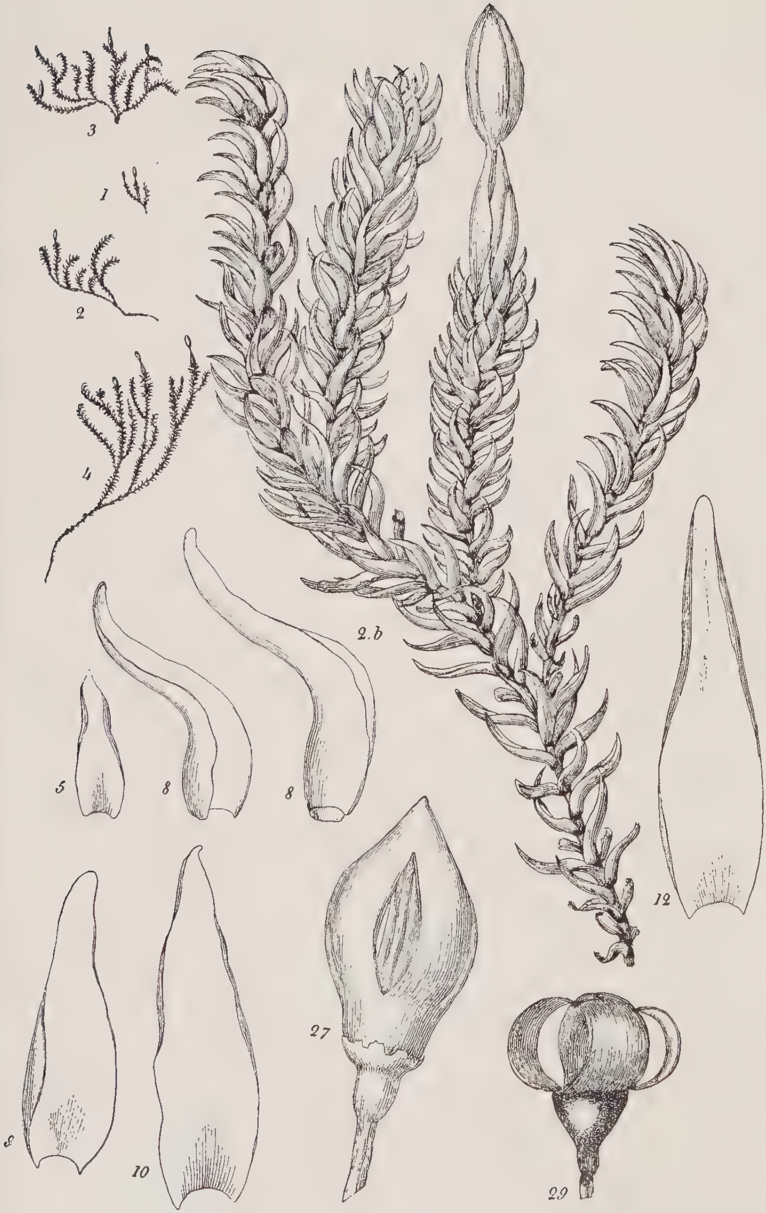


FIGURE 6.
a. Georgia pellucida, × 2. *b.* Gemmiferous branch, × 2. *c.* Capsule, × 10. *d.* Peristome, × 20.

G. PELLUCIDA (L.) Rabenh., the Common Georgia (*Tetraphis pellucida* of many authors), is very abundant on decayed stumps in moist woods. On the western end of Long Island, where decayed wood is scarce, it grows luxuriantly on the banks of brooks in swamps, the black peaty soil being as rich in organic matter as decaying wood.

The Flagellate Dicranum, which in New England grows almost exclusively on decayed wood, on Long Island and southwards has a habitat similar to that of Georgia. This goes to prove that some mosses growing on decayed wood are true saprophytes, although their saprophytism has not gone so far as to enable the plants to dispense with chlorophyll.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2
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2.b
5
8
8
12
27
9
10
29

PLATE X. *Andreaea petrophila* (From Bry. Eur.).

1–4. Plants natural size. 27 & 29. Capsules in different stages of drying. The other figures are self-explanatory.

The Common Georgia has two characteristics that will serve to make its identification easy. Its peristome consists of four long teeth that are readily distinguishable under the lens. It is the only common moss with this number of teeth in the peristome. The other character is the presence of slender plants bearing cup-like clusters of leaves. In this cluster of leaves are minute green bodies, gemmæ, which fall off and give rise to new plants in the same way that the bulblets of Cystopteris give rise to that fern.

It fruits very abundantly and the capsules persist for a year or two, so that there is no difficulty in finding or identifying it. The capsules are in the best condition late in spring or early summer.

The calypta covers the capsule and is whitish-fringed at its lower edge.

G. Brownii (Dicks.) C. M. (*Tetrodontium Brownianum* Schwagr.) is a very rare species found in less than half a dozen places in North America. It is a very small plant with a very few minute leaves at base; entire plant, including sporophyte, less than 1/3 inch in height; capsule oval, *teeth very broadly triangular*, almost equilateral. This species has been found in the mountains of Maine and New Hampshire and in Newfoundland. It often grows inverted on overhanging rocks.

FAMILY 4. POLYTRICHACEAE. The Hair-Cap Family.

The plants of this family are usually of a large size, the simple or slightly branched stems growing from a creeping underground stem (except *Pogonatum brevicaule* and *P. brachyphyllum*). Leaves usually narrow, with the base sheathing or at least with the basal part of the leaf hyaline with larger cells; the costa bears on its upper surface, except at the hyaline base, *longitudinal plates of tissue (lamellae) one cell thick and attached to the upper surface of the costa by one edge*, making the costa appear very wide and dense. The upper leaf cells are usually hexagonal. The plants are usually dioicous with the *antheridia borne in conspicuous terminal rosettes.* The capsule is on a long smooth seta, large, cylindrical or prismatic, with 4–6 angles. The calyptra is cucullate, *covered with a dense felt of hairs, or at least roughened at apex with short spinose projections. Peristome of 32 or 64 teeth, short, without joints, triangular in cross-section. Columella expanded at the top into a circular membrane, the* *epiphragm, which is attached to the tips of the teeth*, and helps control spore distribution. (See Plate VII, figs. 1, 2.)

The plants of this family are among our most common and conspicuous species, and the student will be sure to fall in with them in his first day's study.

KEY TO THE GENERA.

1.	Capsules four or six-angled	*Polytrichum.*
	Capsules cylindric	2.
2.	Calyptra hairy; leaves not crisped when dry	*Pogonatum.*
	Calyptra not hairy; leaves crisped when dry	*Catharinea.*

POLÝTRICHUM. The Hair-Cap Mosses.

The Hair-Cap Mosses, called Bird Wheat or Pigeon Wheat in many localities, are the largest and in some respects most highly developed of all our mosses, and by reason of their size and common occurrence are familiar objects to nearly every one. Many an old field and meadow is carpeted with the dark rich green of the Common Hair-Cap. The farmer, however, votes it a pest, as it often entirely supplants the grass over large areas of meadow.

When dry, even though wholly alive, they burn like tinder. These mosses are used in European countries for small brooms and for filling beds. It is said that the great Linnaeus often slept on such beds.

The hairy cap that gives this genus of mosses its name is composed of long hairs growing from a little scale-like body, the calyptra proper, at the top of the capsule.

The Hair caps, in common with most other mosses, are subject to great extremes of moisture and dryness, and their appearance when dry is very different from what it is when moist, as the leaves fold up against the stem to check the rapidity of evaporation. Some plants that do not produce a sporophyte end in a rosette of highly modified leaves. These are the male plants, and among the leaves of the rosette are numerous antheridia. The male plants of many other dioicous mosses end in a similar rosette. The leaves are large, not bordered, *with a sheathing membranous base* and very numerous lamellæ (see glossary) occupying the greater part of the width of the leaf above the base, making the central portion of the leaf very dark and dense. *Capsules prismatic, four- to six-angled*, often nearly cubical. Peristome teeth generally sixty-four.

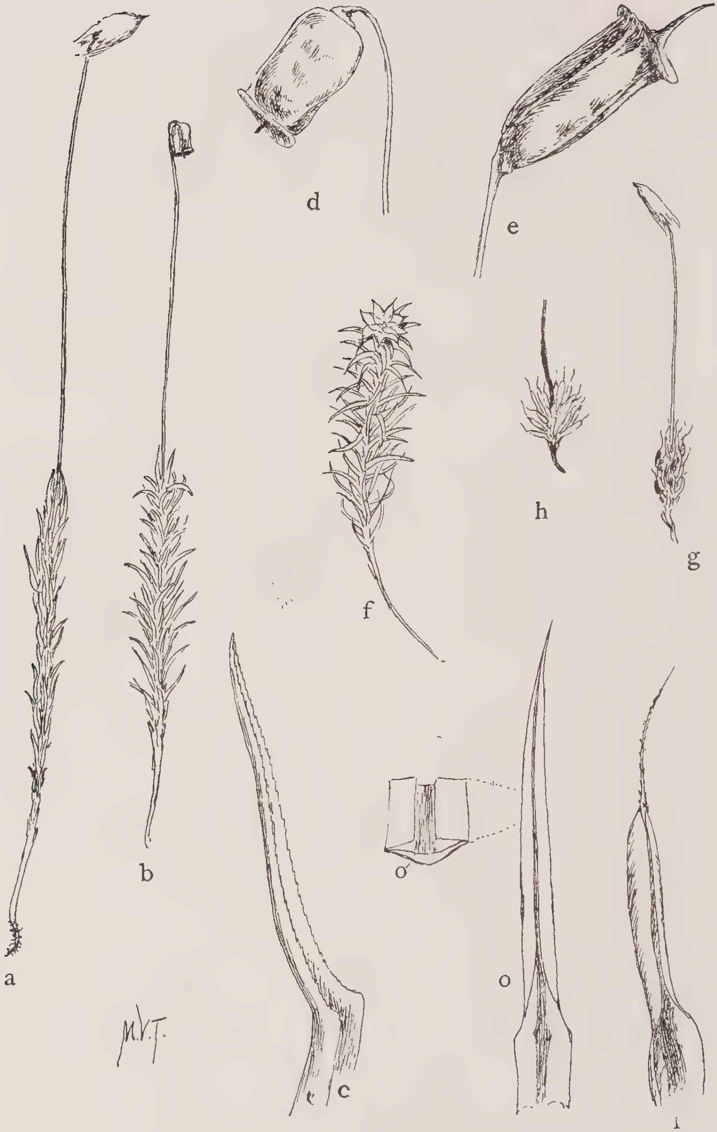


PLATE XI.

a. Fruiting *Polytrichum commune,* × 1, dry. *b.* The same moist with the calyptra removed. *c.* Leaf of the same, × 10. *d.* Capsule of the same, × 5. *e.* Capsule of *P. Ohioense,* × 5. *f.* Male plant of *P. commune,* × 1. *g* and *h. P. piliferum,* × 1, dry and wet. *o.* Leaf of *P. juniperinum,* × 10. *o′.* Portion of the same, × 30. *p.* Leaf of *P. piliferum,* × 10.

Pogonatum is put with the Hair-Caps by some authors, but is readily distinguished by the cylindric capsules. In other respects there is very little to distinguish the two genera.

KEY.

1.	Leaf margins serrate, not infolded	2.
	Leaf margins entire, thin and infolded	4.
2.	Capsule four-angled	3.
	Capsule ovoid, obscurely 4- to 6-angled, beak long	*gracile.*
3.	Capsules cubical, beak short	*commune.*
	Capsules much longer than broad, beak long, neck tapering	*ohioense.*
4.	Plants of dry situations, leaves small with long white awns	*piliferum.*
	Plants larger, leaves without white awns	5.
5.	Plants of lowlands without felted radicles; capsules 3 mm. to 5 mm. long	*juniperinum.*
	Plants of alpine or subalpine regions; stems covered with a dense felt of radicles, capsules 2 mm. to 3 mm. long	*strictum.*

Our species are readily divided into two groups, as shown in the key. One with serrate plane margins and the other with margins thin and infolded, not serrate except at the extreme apex. The plants are so large and the characters so well defined that there will be no need to make use of microscopic characters except perhaps in the case of *P. gracile.* These species are all earth-growing.

P. COMMUNE L., Common Hair-cap, Plate XI and Fig. 7, is our largest moss, sometimes having stems a foot long, although usually much smaller. It is one of the most widely distributed of plants, being found in all parts of North America, in Europe, and in Asia. It is also one of the very few mosses put to some economic use. The extreme forms are described as varieties by Mr. J. F. Collins in Rhodora for July, 1906. Also Bryologist, Nov. 1906.

A decoction of this plant was formerly much used to aid in the growth of the hair in accordance with the curious old doctrine of signatures which taught that the medicinal uses of plants were shown by their shape and structure; *e. g.* cordate leaves were supposed to be good for the heart and Hair-cap Mosses for the hair.

The leaves of the Common Hair-cap are very thick and strong, with a thinner clasping base and serrate margins. The young sporophytes appear in late autumn or early spring and the capsules mature in June or early July.

The Common Hair-cap is variable in nearly all its parts. The var. *perigoniale* is a form with very long whitish-membranous and long-awned perichaetial leaves. The var. *uliginosum* has the leaves spreading-recurved when dry; the stems more slender and less rigid than usual.

P. OHIOENSE R. & C., Ohio Hair-cap, Pl. XI and Fig. 8, without the capsule is not readily distinguished from the Common, as leaves and general appearance are very similar. But with the sporophyte present the distinctions are clear. Note that the capsule of the Common Hair-cap is almost cubical, that the lid has a very short beak, and that the capsule is entirely covered by the calyptra. The capsule of the Ohio Hair-cap is elongated, slender, with a taper-

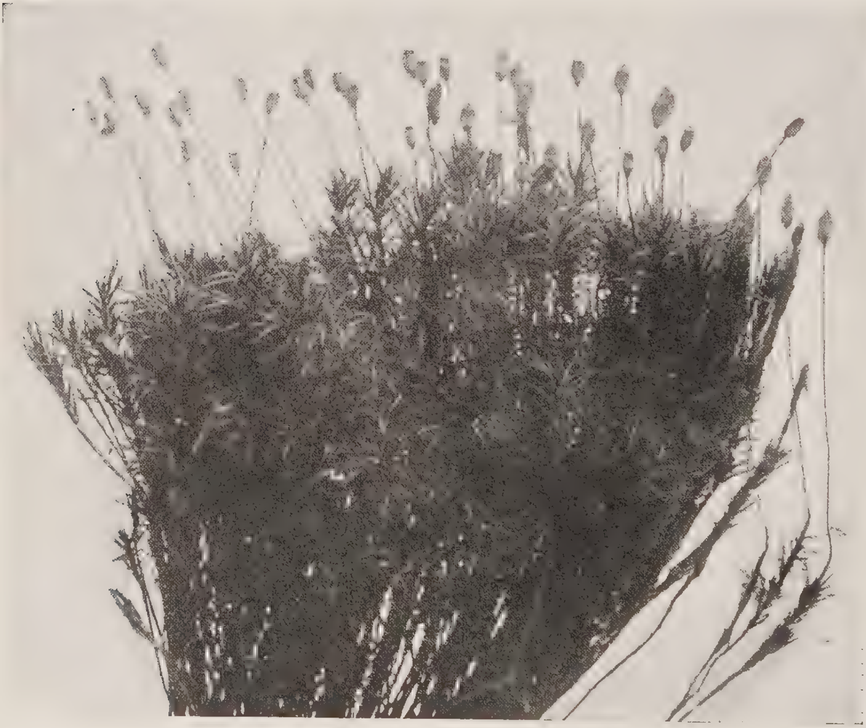


FIGURE 7.

Polytrichum commune, × 1 (Young fruits, capsules droop later).

ing neck; lid much longer-beaked. The lid and the calyptra of the Ohio Hair-cap fall early in June, very soon after the spores are ripe, and it is not always easy to find either in position; but, if the calyptra be found, it will be seen to cover the upper portion of the capsule only. The Common Hair-cap, although occurring in woods, is most common in open fields. The Ohio Hair-cap is most frequent in shady, more moist spots, often in deep woods.

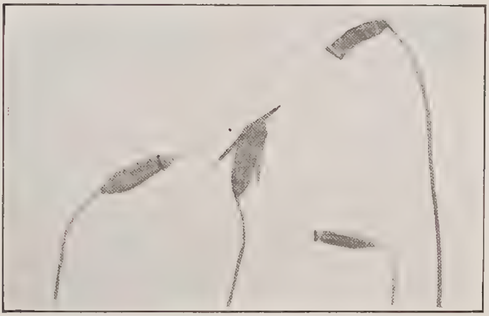


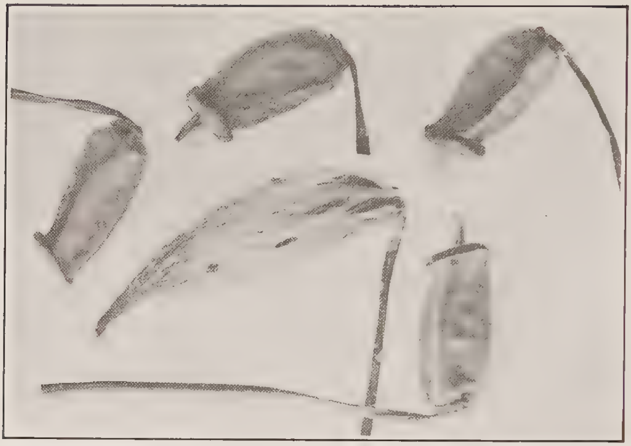
FIGURE 8.

Capsules of *P. Ohioense*, × 2.

P. GRACILE Dicks. is a rare form, which I believe is often confused with *P. ohioense.* The length and the number of angles of the capsule are somewhat variable, although the capsules usually have more than four angles. Microscopic sections of the leaves are necessary definitely to determine this species.

P. JUNIPERINUM Willd., Juniper Hair-cap, resembles *P. commune* very closely in general appearance except for the light *glaucous-green color of its open leaves,* so different from the dark green of the latter that they are strikingly distinct at a glance when moist, especially if the two species are growing intermingled, as they often do. It usually grows in drier situations than *commune.* A glance at the upper surface of the margins of the leaves under a hand-lens will serve to distinguish the two species without the shadow of a doubt. This species matures its spores at about the same time as *commune* or possibly a little later. (Plates XI and XII.)

P. PILIFERUM Schreb., the Awned Hair-cap, has the same light color as the preceding and also has its leaf-margins turned in, but the



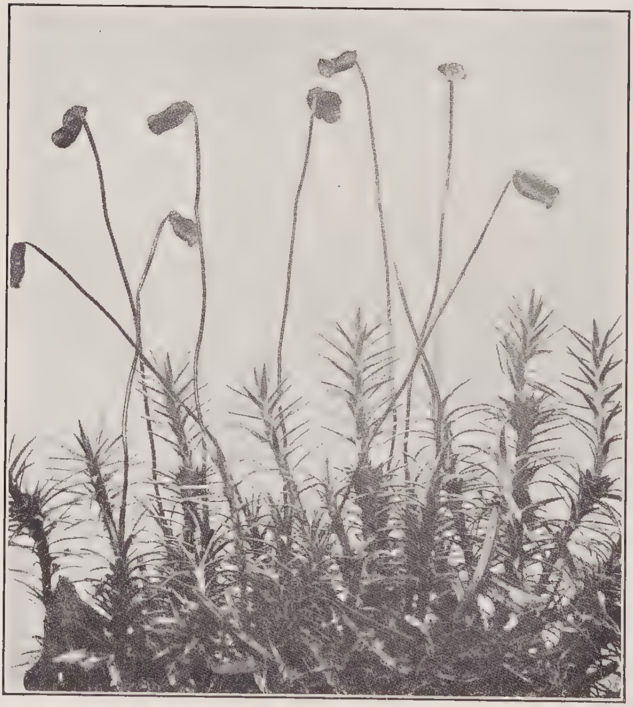


PLATE XII.

FIGURE 1. Capsules of *Polytrichum juniperinum*, × 5.

FIGURE 2. *P. juniperinum*, × 1¼, showing old capsules, new fruits and old male plants with new shoots.

leaves differ in shape as shown in the figure, and end in long white awns. The entire plant is much smaller than in any of the other species, rarely growing larger than the figure. It also grows in much drier places than the other species, the thin layers of soil around the edges of ledges in dry pastures being a favorite habitat. It matures in June and July. It is very common in Gilpin Co., Colo., at an altitude of 8000–12000 ft. (Plate XI and Fig. 9.)

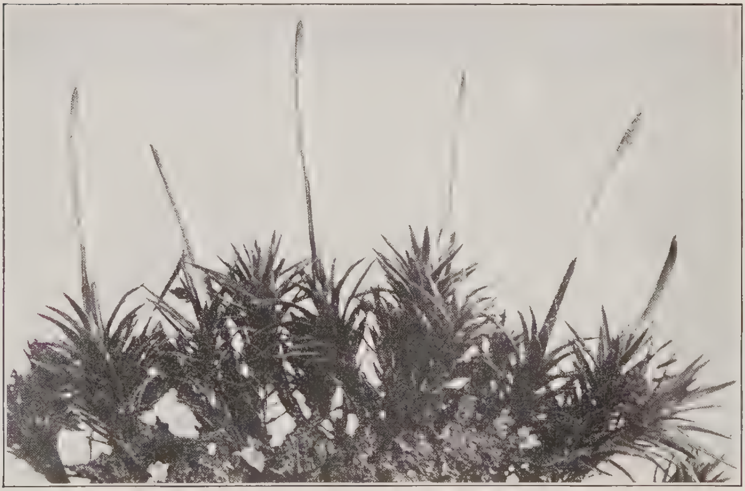


FIGURE 9.

P. piliferum, × 5. Young fruits.

I have found this species on ledges next the bare rock, next it but farther from the ledge the Juniper Hair-cap, and in moist depressions in the ledge the Common Hair-cap, growing on the accumulated soil and humus.

P. STRICTUM Banks will surely be found by all mountain climbers. It is very common in open boggy places at an altitude of 3000 feet or more. It is closely related to *P. juniperinum*, but is readily distinguished by the *more slender densely radiculose* stems and the *much smaller capsules*. It is also found occasionally in cool peat bogs at all altitudes.

POGONÀTUM Beauv.

The Pogonatums differ from the Hair-caps mainly in the rounded cylindrical capsules, not square or angled, they may be straight or curved. The lid is beaked, there is no hypophysis and the lens shows only 32 peristome teeth.

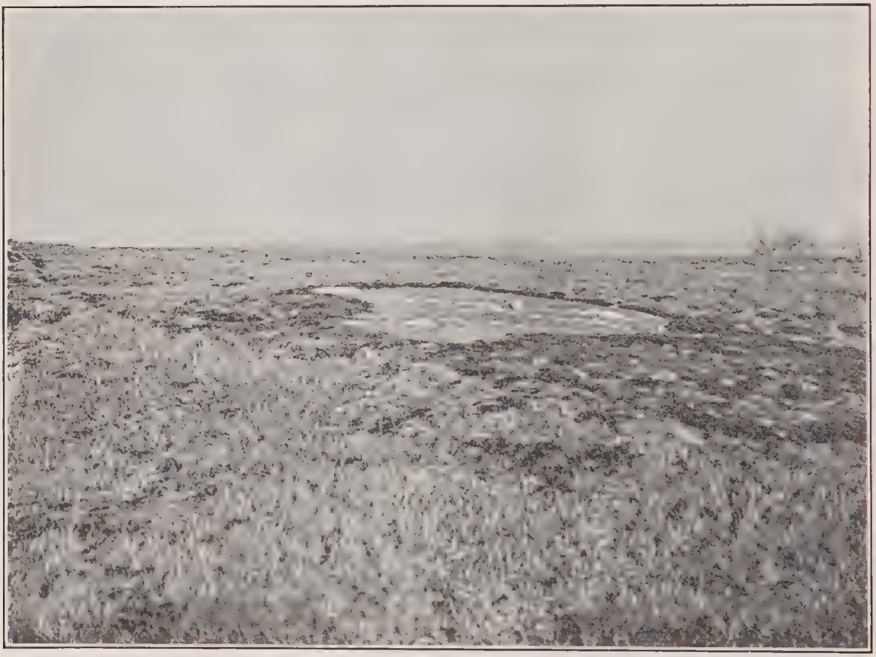


FIGURE 10.

Polytrichum commune and *P. piliferum* growing around the edge of a ledge on the site of the old village of Newfane, Vermont, and gradually covering it. The dark areas are *Polytrichum*, the lighter ones are sedges and grasses growing on soil formed by the mosses. Next will come shrubs and later spruce trees. It will take much more than one hundred years to produce trees like those in Pl. II.

KEY.

1.	Plants scattered, arising from a persistent green felt-like protonema; stem very short; leaves few and small	2.
	Plants growing close together with the appearance of *Polytrichum;* stems ½ to 3 or more inches long; leaves large, slender and numerous	3.
2.	Leaves narrow, sharp pointed; capsules usually more than twice as long as broad, usually straight but some often inclined or drooping; calyptra gray	*P. brevicaule.*
	Leaves broader, tongue-shaped; capsules less than 2:1, usually curved and unsymmetric at base; calyptra tawny red-brown	*P. brachyphyllum.*
3.	Plants dark green; capsules long-cylindric and curved	*P. alpinum* var. *arcticum.*
	Plants glaucous green when fresh and moist; capsules shorter and erect	*P. urnigerum.*

P. BREVICAULE (Brid.) Beauv., the Short Pogonatum, [*P. tenue* (Menz.) E. G. B.] is probably the most common of our species. It grows on bare moist banks of clay or loam where other plants have not yet obtained a foothold. The plants do not grow close together, as with most mosses, but *singly and scattered, the soil between them being covered with green felt-like protonema.* All mosses grow from just such green felt; but after the moss plant proper has developed, the protonema usually disappears. In *P. brevicaule,* however, the protonema is persistent and plays an active part in the nutrition of the plant, seeming to perform the function of leaves, for the leaves on this plant are very few and short as compared with the allied species. This is well illustrated by the figures, the dark shaded upper portion of the leaf being the only part that contains chlorophyll and therefore the only portion that performs the functions of a leaf. These marked and interesting modifications may be due to the fact that this moss grows on freshly disturbed earth, and by this method is enabled to fruit before its competitors for the space are able to develop.

The leaves are narrow sharp-pointed and serrate. The capsules are cylindrical, erect or inclined by the bending of the seta; 2–6 times as long as broad, usually straight. Calyptra light gray with sometimes a slight tinge of brown. Fruit ripens in autumn, often remaining in good condition until spring.

P. BRACHYPHYLLUM (Mx.) Beauv. Short-leaved Pogonatum. (Fig. 11 b.)

This species is frequent on sandy soil from the Middle Atlantic states southward. It has been found as far north as eastern Long Island.

It has much the habit and appearance of the last from which it is readily distinguished by its shorter capsules (less than 2:1), usually unsymmetric and curved at base and covered with a *tawny red-brown calyptra.* The leaves are *tongue-shaped and entire.* Spores ripen in January and February.

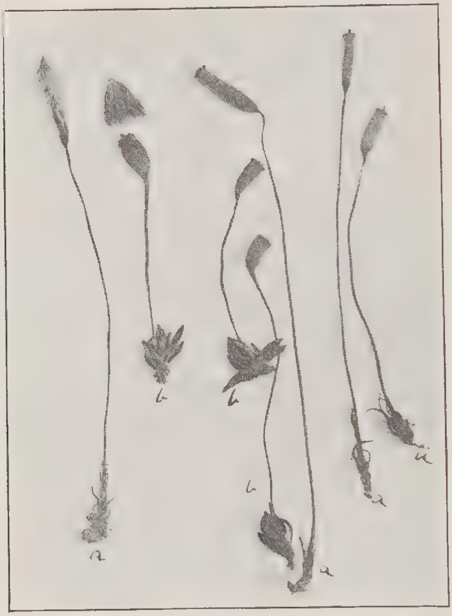


Figure 11.

a. Pogonatum brevicaule. b. P. brachyphyllum. All, × 4.

Occasionally there are plants of *P. brevicaule* with capsules as short and broad as the larger forms of *P. brachyphyllum* but the unsymmetric base, tawny calyptra, and broad leaves of the latter will prevent confusion.

P. alpinum (L.) Roehl. var. arcticum (Sw.) Brid. This species is common in woods and cool shaded places in mountainous regions. It is at once recognized by its larger size, dark green color and long

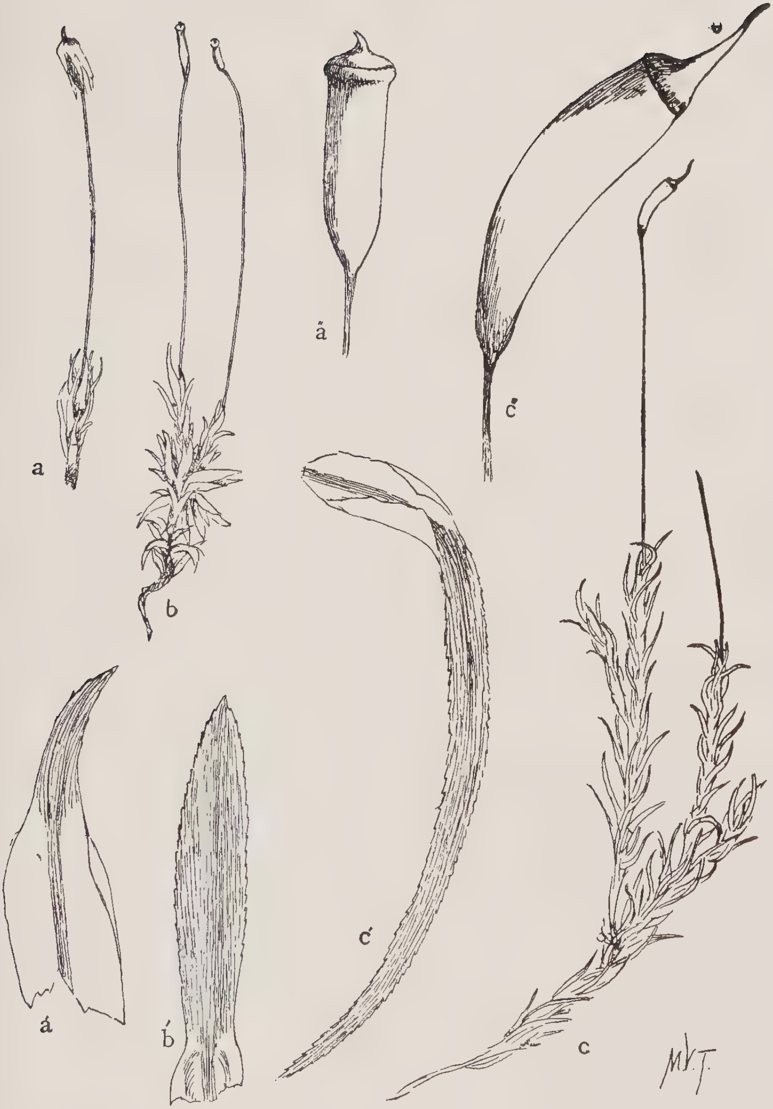

a
b
a''
c''
c'
a'
b'
c
MVT

PLATE XIII.

a. Pogonatum brevicaule, × 2. *a'. Leaf*, × 15. *a''. Capsule*, × 10. *b. P. urnigerum*, × 2. *b'. Leaf*, × 10. *c. P. alpinum*, × 2. *c'. Leaf*, × 10. *c''. Capsule.* × 10.

curved capsules with long-beaked lid. The leaves also are much longer and more slender and are like those of the larger hair-caps for which sterile specimens might be mistaken. The capsules mature in June or July. The var. *arcticum* is scarcely branched, but the typical form of *P. alpinum* from Europe is about as freely branched as the next.

P. URNIGERUM (L.) Beauv. also is most abundant in much the same kind of places as the last but is much more local and rarer in its distribution. Its color is a bright glaucous green. The plants grow in widely extended colonies and are freely branched but average shorter than *P. alpinum arcticum*. The capsules are *straight and erect* with the beak on the lid much shorter than in the last. Spores ripe in autumn. (Oct., Nov.).

P. CAPILLARE (Mx.), Brid. will be found on most of our higher mountain-tops. It has broad leaves like those of *P. urnigerum*, but they are much more strongly curved when dry. It is also much smaller, with simple unbranched stems and shorter capsules.

CATHARÍNEA.

The Catharineas are very closely related to the Hair-caps, but have the calyptra nearly bald. It is merely roughened with a few vestigial hairs. For this reason it has been called *Atrichum*, meaning without hairs. *Polytrichum* means many hairs. The leaves are not sheathing and but slightly embrace the stem, lingulate or ovate-oblong, crisped when dry; margins bordered, serrate, teeth often in pairs. Capsule cylindric, often somewhat curved; operculum long-rostrate; peristome of thirty-two teeth.

The capsules of the Catharineas are in good condition from late autumn to early spring.

KEY.

1.	Capsule 4:1; leaves not at all wavy on the margins when moist, midrib narrow	*crispa.*
	Capsule 6–8: 1; leaf margins wavy when moist	2.
2.	Midrib constituting 1-8—1-10 of leaf	*undulata.*
	Midrib constituting 1-3—1-4 of leaf	*angustata.*

C. UNDULATA (L.) W. & M., Wavy Catharinea. Leaves lingulate, strongly undulate when moist and strongly spined at the back.

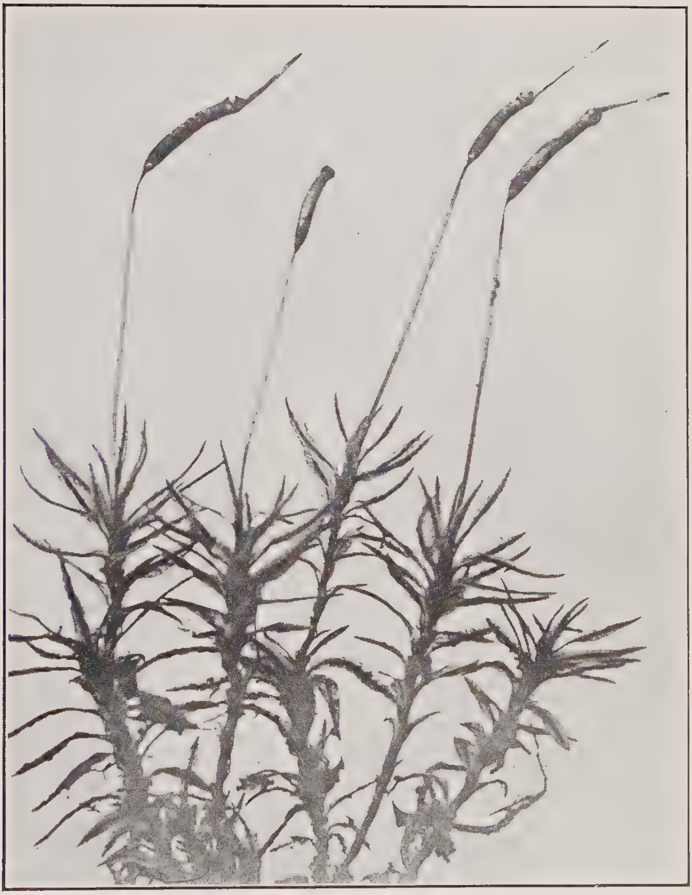


PLATE XIV.

Catharinea undulata, × 2. (moist).

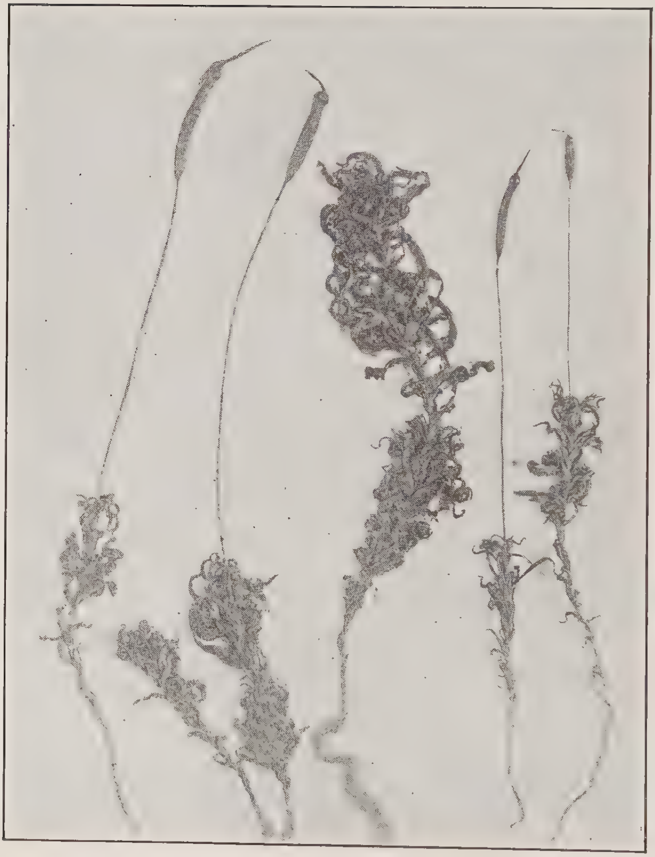


Plate XV.

Catharinea. 4 plants of *C. undulata* at the left, 2 of *angustata* at the right, × 2. (dry).

Occasionally specimens are found with two or more setae from a single plant.

The Wavy Catharinea is one of the very common mosses, occurring everywhere in eastern North America. It seems to be rather rare on Long Island, but in most parts of the country it is exceedingly common. It grows best on moist shady banks of brooks. It can easily be recognized by its long slender slightly curved capsules, leaves strongly crisped when dry, with a narrow midrib due to few and short lamellae. (See glossary.)

C. ANGUSTATA Brid., Narrow-leaved Catharinea, resembles the Wavy Catharinea very closely, but grows in drier, more sandy soil, and is usually much smaller with narrower straighter capsules, as shown in the cut. The only sure way to distinguish them is by the leaves. Although the leaf of the Narrow-leaved Catharinea is narrower, the midrib is much broader, constituting one-third to one-quarter the breadth of the leaf. The two species grade into each other in a most puzzling way and it will be difficult to place many forms even with the compound microscope, also there are possibly two or three other species occurring frequently. The plants photographed are regarded as being typical.

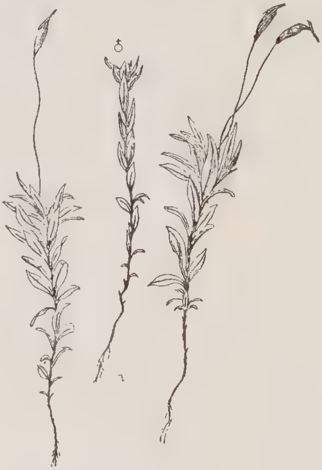


FIGURE 12.

Catharinea crispa, × 1.

C. CRISPA James is a rare species in most parts of the country, but it is common in swamps along the south shore of Long Island. It will probably be found fairly common along the Middle Atlantic coast. It has also been found sterile on Mt. Greylock, Mass.

Its leaves are oval-oblong, thrice as broad in proportion to their length as those of *C. undulata, not at all wavy when moist, and not spinose upon the back;* the lamellae appear as darker lines on the costa, but do not materially increase its apparent width. The capsule is much shorter than in either of the other species but otherwise is much the same. When sterile, this species is almost sure to be mistaken for a *Mnium.*

FAMILY 5. BUXBAUMIACEAE. The Buxbaumia Family.

The plants of this interesting family are small, almost or quite stemless, with leaves few or none. They grow on earth or rotten wood. Leaves are present but often disappear long before the maturity of the capsule. Capsule very large in proportion to the size of the plant, oblique and asymmetric. Calyptra small, conical. Peristome single or double, forming a whitish cone.

A most peculiar and fantastic family, the members of which will readily be recognized by a comparison of the figures given under the species.

BUXBAUMIA. Haller.

The illustrations speak for themselves. No one who finds the queer-looking objects figured here will have any difficulty in identifying them.

The leaves are few and are clustered at the base of the seta. They entirely disappear before the capsule ripens, so that the mature plant consists of only the roughened seta with a few rhizoids at the base and the queer buglike capsule. Mrs. Britton calls the Buxbaumias "The Humpbacked Elves." To the author they look like bugs on a stick. We have two species in eastern North America, *Buxbaumia aphylla* L., and *B. indusiata* Brid.

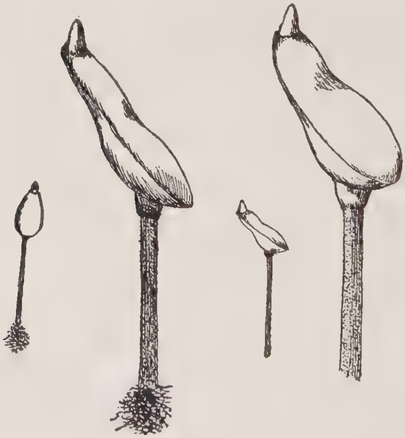


FIGURE 13.

Two different views of *Buxbaumia aphylla*, × 1. Two different views, × 4.

B. APHYLLA, Figs. 13 and 14, has the capsule red-brown shining, strongly flattened above; spores maturing from December to June, occasionally found mature in September. Plants growing on soil.

B. INDUSIATA has the capsule green or yellow, dull, little flattened above; roundish as in Fig. 14, outer peristome of four concentric rows of linear teeth, of which the outer row is short and the inner more than half the length of the cone; spores maturing a month or so earlier than in the preceding. Plants growing on very rotten wood, rather smaller. Both species are widely distributed across the continent, but *B. aphylla* is much the more common.

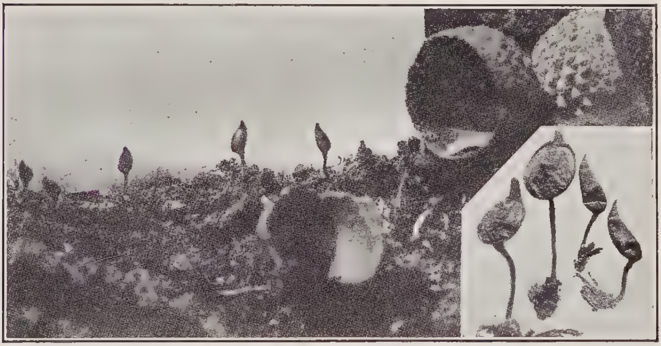


FIGURE 14.

Buxbaumia aphylla. Photo by G. E. Nichols. Insert, *B. aphylla* (left) and *B. indusiata* (right) × 1.

WÉBERA.*

Much more common than Buxbaumia and scarcely less interesting is the odd little Webera shown in Fig. 16. The capsules have much the same one-sided tilt, but are less irregular in outline and are partially incased in the fringed perichaetial leaves. The capsule resembles a grain of wheat in appearance and is almost sessile, the seta being so short as to be scarcely apparent. The leaves are persistent and the non-fruiting plants are frequently so abundant as to make a broad mat of dark green, dotted here and there with the lighter colored capsules. In looking for Webera search for a moist bank where there is little or no tall vegetation, and which at a little distance appears dark green mottled with white. (The white is a lichen that is nearly always found with the Webera.) Webera is so common and so easily recognized that every lover of mosses should be able to collect it in his home locality. The capsules persist for a long time, but July is a good time to collect this species.

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* We have but one species of Webera, *W. sessilis* (Schmid.) Lindb.—*Diphyscium foliosum* of many authors.

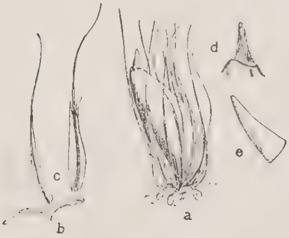

FIGURE 15.

a. Webera sessilis, × 4. *b.* Leaves, × 4. *c.* Perichaetial leaves, × 4. *d* and *e.* Peristome and operculum, × 10.

In Webera, as well as in Buxbaumia, the upper surface of the capsules is flattened in cross-section and the capsules all point in the direction of the light supply, often looking like soldiers in close array at "shoulder arms." Both the po-

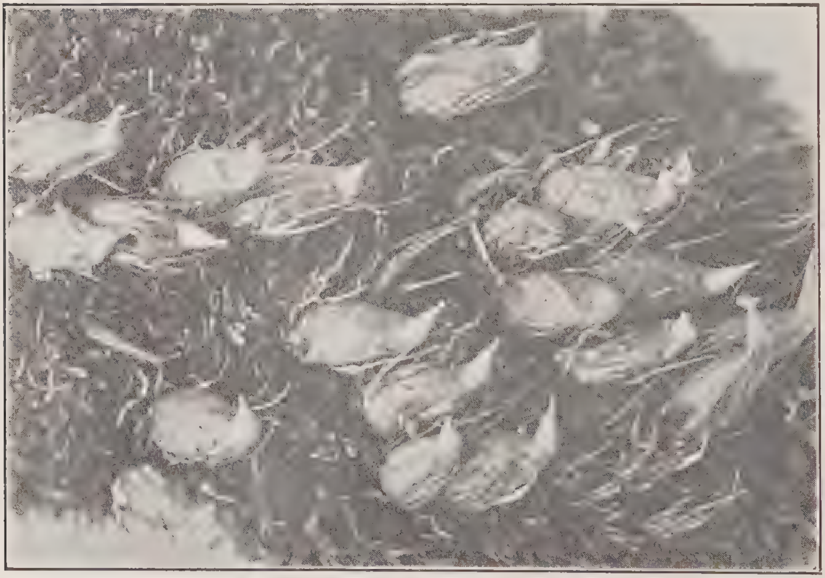

FIGURE 16.

Webera sessilis, × 5.

sition of the capsule and the flattening of the upper surface are adaptations for light absorption, but in Webera the first drops of rain that fall in a storm strike the upper surface (See "Goebel Organography," Pt. I, p. 237, Balfour's translation) and send the spores out in little puffs, sometimes to a height of two inches. This effect can be produced by tapping a mature deoperculate capsule lightly upon the upper side. Note how the nozzle-like peristome is pointed straight up so that the spores are fired as high as possible from the miniature powder gun. It seems probable that the wind which accompanies summer storms serves further to disperse these spores and that the ejection of the spores ceases after the capsules are well wetted; but this needs further investigation.

It also seems perfectly sure that other agencies than raindrops will serve to force the spores out of Webera and Buxbaumia's "powder guns;" for example, the impact of the feet of large insects and other small animals. Perhaps the jet of spores may leave some clinging to the hair or fur of the animals which discharge them, and through that means they may be carried for considerable distances.

FAMILY 6. FISSIDENTACEAE. The Fissidens Family.

This is one of the most natural and easily recognized of the families of mosses. Only one genus, Fissidens, is common and the characters of this genus are the characters of the family for the most part.

FÍSSIDENS.

The leaves of Fissidens are in two rows on opposite sides of the stem and both rows lie in the same plane, giving the plants a peculiar flattened appearance like the Hepatics. The leaves are vertically placed and apparently split along the basal portion of the upper margin so as to clasp the stem and the base of the leaf next above.

The leaf-cells are small, rounded or hexagonal. The sporophyte is lateral or terminal, exserted; peristome like that of *Dicranum*, with sixteen forked, highly colored teeth, which are often papillose above.

The peculiar structure of the leaf has been explained in several ways, but the explanation given by Robert Brown in 1819 has recently been verified by the studies of Mr. E. S. Salmon.

According to this theory the clasping portion of the leaf represents the original leaf, while the rest of the leaf is made up of lamellae, one dorsal and the other terminal. This theory is strongly confirmed by the fact that these supposed lamellae are wanting in the perigonial leaves and very much reduced in size or wanting in the lower stem leaves. Moreover, the peristome shows this family to be closely related to the *Dicranaceae*, in which dorsal lamellae are often strongly developed.

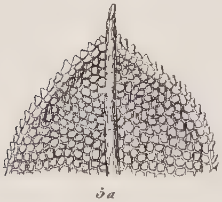

FIGURE 17.

Leaf-apex of *F. taxifolius* (From Bry. Eur.).

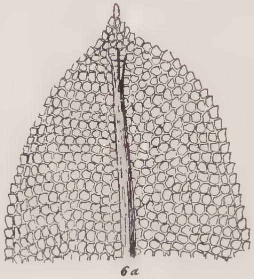

FIGURE 18.

Leaf-apex of *F. osmundioides* (From Bry. Eur.).

The leaves are often bordered, sometimes with a number of elongated cells, much as in *Mnium*, but, more frequently, with cells of the same shape and size but of a different color; the border is usually too narrow to be distinctly made out with a hand-lens.

F. CRISTATUS Wils. is apparently the most common species in New England. It grows on moist soil or stones in shaded places. The *sporophyte is lateral* and the leaves are margined with a border of lighter cells as shown in the plate of *F. adiantoides*.

F. ADIANTOIDES (L.) Hedw. can be told from *F. cristatus* with certainty by the compound microscope alone. The latter species

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PLATE XVI. *Fissidens adiantoides*. (From Bry. Eur.).

5. Plant natural size. 8. Perigonial leaf. 9–11. Leaves. 11 x. Cross sections of the lower part of leaf. 11 a. Apex showing border of lighter cells.

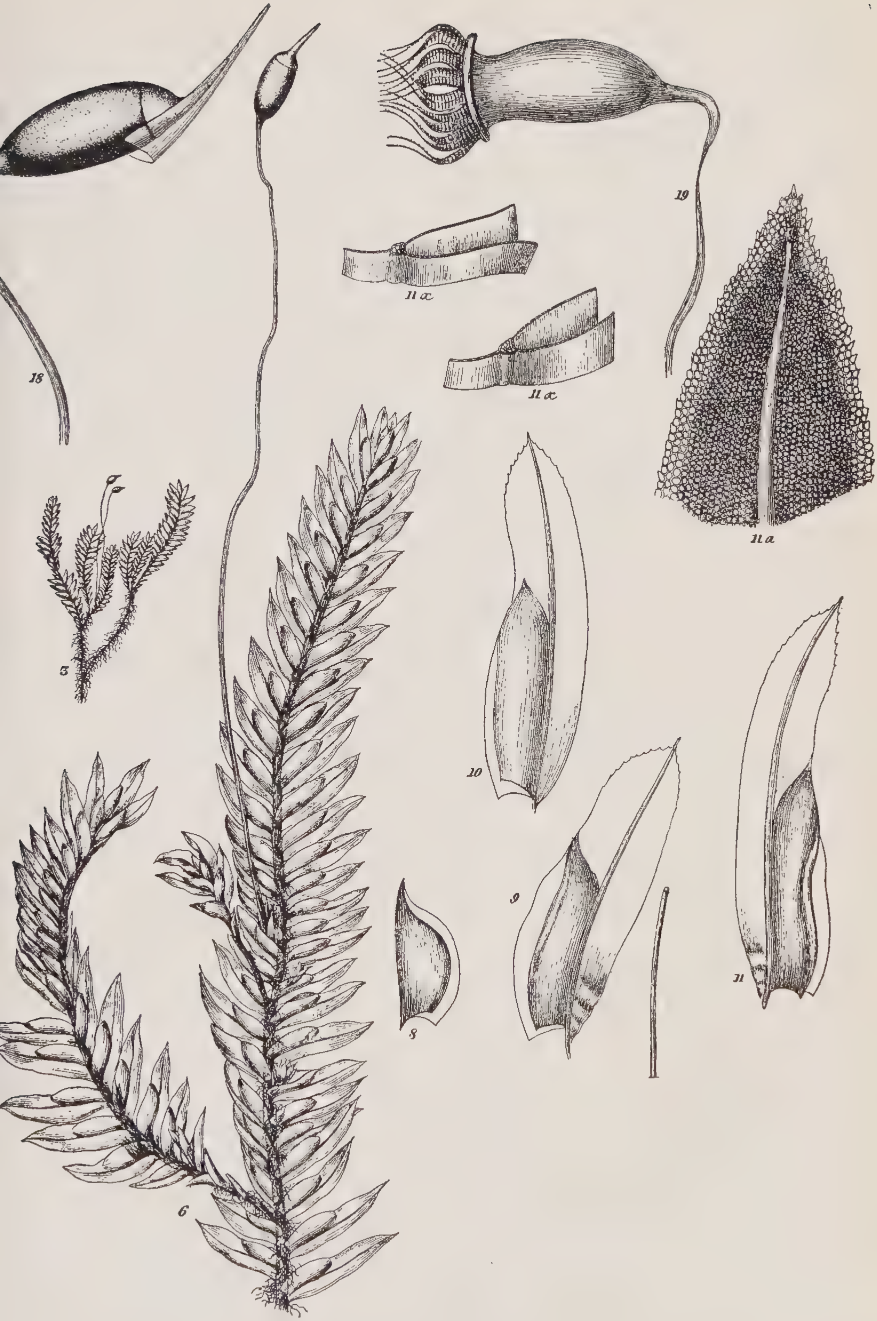
18
19
11 α
11 α
11 a
5
10
9
8
11
6

Plate XVI.

(See explanation on preceding page.)

seldom reaches more than an inch and a quarter in height while *F. adiantoides* may be two or three inches high. Both species mature their spores in winter.

F. OSMUNDIOIDES (Swtz.) Hedw. is one-fourth to two inches in height (rarely twice this); leaves not bordered; dioicous; with *terminal sporophyte;* capsule suberect or inclined; operculum with a needle-like beak nearly as long as the rest of the capsule. Spores mature in *summer* (July). Common on various substrata.

F. TAXIFOLIUS (L.) Hedw. is usually less than ½ inch *in height; sporophyte lateral;* capsule inclined, often cernuous; beak of operculum long, usually bent at base; spores maturing in late autumn or winter. On damp clayey soil. Its "ear-mark" is the *excurrent costa.* Common in the vicinity of N. Y. City.

F. JULIANUS (Savi.) Schimp. grows on stones in brooks and looks like a small *Fontinalis.* The lens readily shows the leaf structure to be that of *Fissidens.* This species is frequent in brooks in New York and New Jersey in the vicinity of New York City. (See Pl. XVII).

FAMILY 7. DICRANACEAE. The Dicranum Family.

The plants of this family vary in size from exceedingly minute to several inches in height. The leaves are broadly lanceolate to subulate, often sheathing at base, costate; leaf-cells square, or rectangular to linear, filled with chlorophyll above, more elongated and with little or no chlorophyll toward the base, often with special inflated cells at the basal angles. The calyptra is smooth, narrow, and cucullate. The capsules are on elongated setae, narrow, oval to cylindrical, frequently cernuous and curved; operculum usually long-beaked; peristome of 16 teeth which are *cleft half-way to the base or further into two lanceolate or subulate divisions,* usually of a reddish color, transversely barred.* There are a few cleistocarpous species with capsules rounded and immersed or elongated and exserted.

The leaf character and the peristome when present will usually indicate the family to one who is at all familiar with it. The plants of this family are inhabitants of soil and rocks, rarely growing on trees, frequently on decaying wood.

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*For an illustration of a Dicranum peristome and a description of its workings, see Plate VIII.

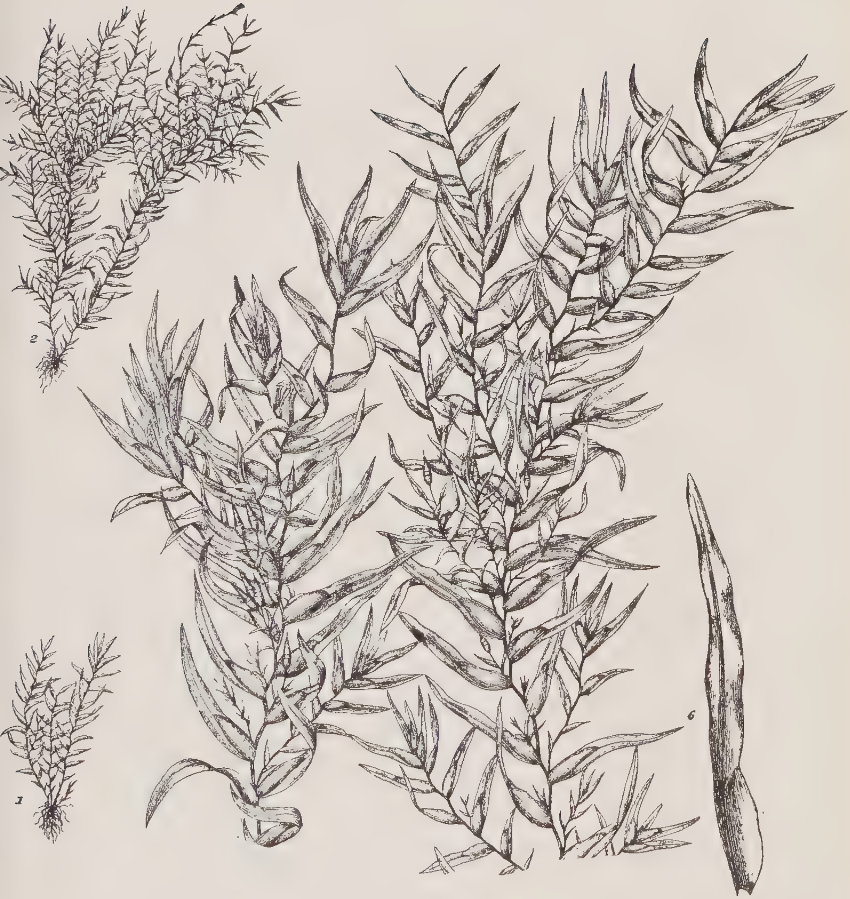

Plate XVII.

Fissidens Julianus (From Bry. Eur.). 1 and 2. Plants natural size.

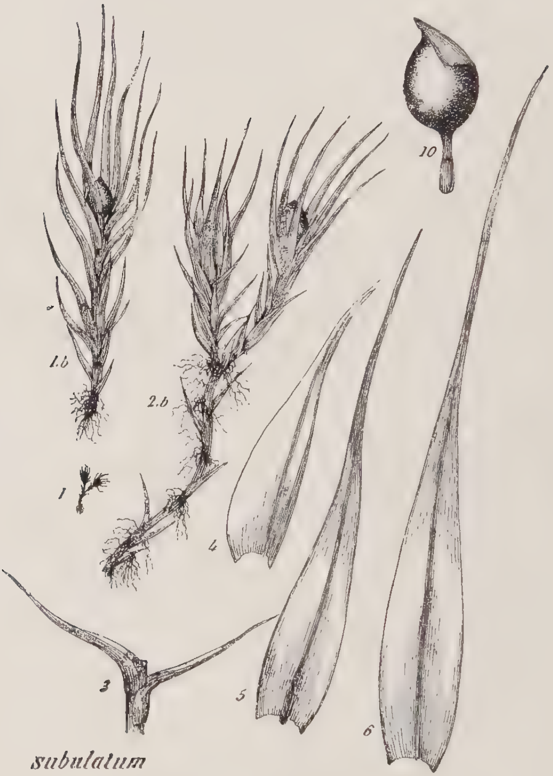

FIGURE 19. *Pleuridium subulatum* (From Bry. Eur.).

1. Plant natural size. 3. Basal part of stem with leaves. 4, 5, and 6 are leaves from different parts of the stem.

PLEURÍDIUM.

Pleuridium and Bruchia are both exceptions to most of the statements made above, as they are degenerate members of the family.

P. SUBULÀTUM (L.) Rabenh. Down among the tufts of grass in dry and sandy fields in early spring, one can find soft silky tufts

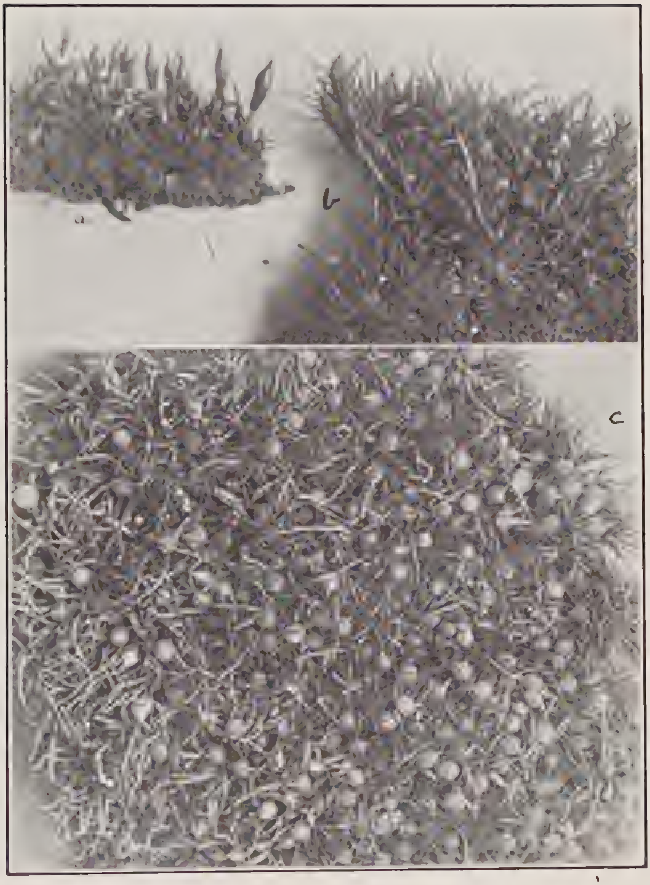

PLATE XVIII.

Fig. *a*. *Bruchia Sullivantii*, × 5. *b* and *c*. *Pleuridium subulatum*, × 5.

of green containing innumerable little green spheres like emerald dewdrops. These green spheres are the capsules nestling among the leaves because of the shortness of the setae. The illustrations can give no idea of the beauty of a dense tuft several inches square, fresh from the field, wet with the spring snows and rains.

The plants are one-twelfth to one-eighth inch high; the spores mature from April to June. Not uncommon in old fields on sandy banks, etc., less frequent northwards.

As shown in the figures the leaves taper gradually to the apex. In *P. alternifolium*, which is not rare near the coast, the plants are about one-fourth inch in height and have many of the leaves so suddenly narrowed as to resemble a ladle in outline.

BRÙCHIA.

Bruchia is named after one of the famous old world bryologists, Ph. Bruch, one of the authors of the great Bryologia Europaea, from which many of our illustrations are taken. Our most common species is:

B. SULLIVANTII, named by Austin after Sullivant, the greatest American bryologist, so that this little plant is very interesting for its name alone. It may be found growing with Pleuridium, but it is at once distinguished by its partially exserted, pear-shaped capsule and mitrate calyptra. Its spores mature about two weeks later than those of *Pleuridium subulatum*. Neither Pleuridium nor Bruchia have lid or peristome, but set free their spores by the irregular breaking apart of the capsule (cleistocarpous).

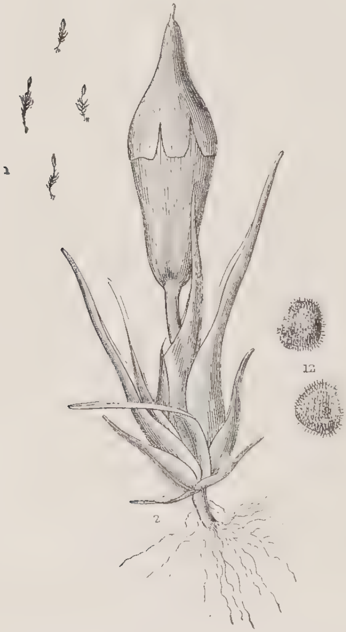

FIGURE 20. *Bruchia Sullivantii.*
1. Natural size. 2. Magnified. 12. Spores highly magnified (From Sulliv. "Icones").

ASTOMUM.

A. Sullivantii Schimp. is associated in habitat with the two mosses mentioned above and is also small and cleistocarpous so that it is better to treat it here, although it belongs in the Tortula family. The plants are larger than in Pleuridium or Bruchia and are readily distinguished when dry by the spirally twisted leaves and also by the fact that the spores begin to mature in the fall. The plants without fruit much resemble *Weissia viridula* and the cuts of that moss will help in the study of the leafy part of this. The lower part of the stem is omitted in the cut and the capsules are usually much more concealed by the leaves when dry: indeed they are so hidden as to be often overlooked; the plants are undoubtedly mistaken for sterile *Weissia viridula.*

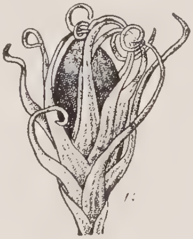

Figure 21. *Astomum crispum* (From Dixon and Jameson).

Scarcely to be distinguished from *A. Sullivantii* with the hand-lens.

DÍTRICHUM.*

D. vaginans (Sulliv.) Hampe, the Dark Ditrichum, has a habitat very similar to that of Ceratodon and at first sight might be confused with it. The capsules are much the same color and somewhat furrowed, but it is smaller with more erect symmetric capsules that have much less conspicuous furrows when dry, often smooth. Leaves scarcely secund; perichaetial leaves sheathing. It matures its spores late in autumn, which of itself will be sufficient readily to distinguish it from Ceratodon. It is not frequent in the more northern portion of our range.

D. tortile (Schrad.) Hampe, the Brown Ditrichum, is frequent throughout in moist sandy or gravelly soil by roadsides and in old fields. It is closely related to the preceding, but is smaller, with light brown capsules which mature at about the same time and are smooth when dry. The leaves are usually secund, perichaetial leaves not sheathing.

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* *Ditrichum* Timm. = *Leptotrichum* Hampe.

It is more common than the Dark Ditrichum, especially northwards. It grows in more moist places of the same general nature, being especially fond of moist banks of recently disturbed soil, which as yet have not become occupied with other vegetation. The young sporophytes sometimes bend over towards the light until they are parallel with the incident solar rays, so that the young

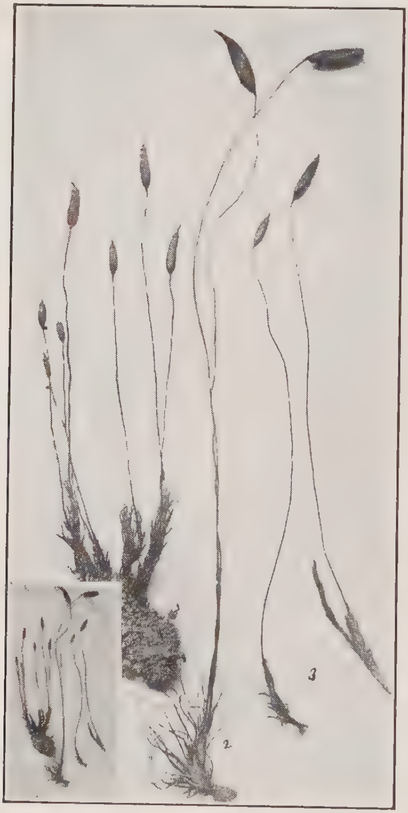


FIGURE 22.
1. *Ditrichum tortile.* 2. *D. pallidum.* 3. *D. vaginans.* All, × 4.
(Insert, 1 × .)

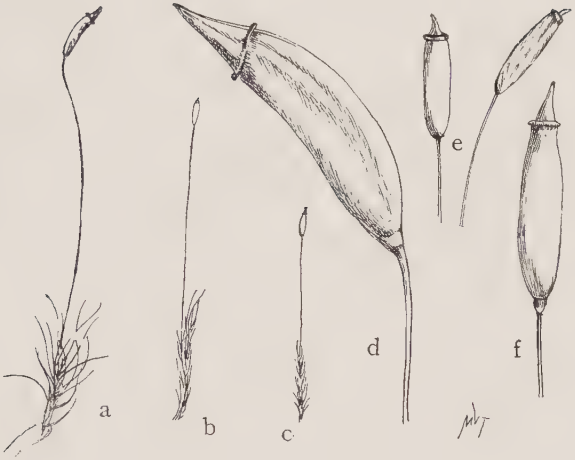


FIGURE 23.

a, *b*, and *c*. *Ditrichum pallidum*, *vaginans* and *tortile* respectively, × 2. *d*. Capsule of *D. pallidum*, × 20. *e*. Capsules of *D. vaginans*, × 10. *f*. Capsule of *D. tortile*, × 20.

green capsules with their abundant assimilative tissue are equally illuminated on all sides. Such plants remind one very strongly of house plants in a window. Its spores mature in autumn. It is a most variable species in pretty nearly every character.

These two species often grade into each other and the Dark Ditrichum is probably only a variety of the Brown.

The Red Didymodon [*D. rubellus* (Hoffm.) B. & S.] somewhat resembles the Dark Ditrichum, but is more red than brown and its leaves are two or three times as long and somewhat curled when dry. It belongs in the Tortula family, although evidently related to the Ditrichums.

D. PALLIDUM (Schreb.) Hampe, the Yellow Ditrichum, is more abundant southwards and in the lowlands, and is much larger than the other two species. It is easily recognized by its bright yellow setae and unsymmetric capsules, which mature in late spring. It is most frequent in dry sandy soil.

ONCÓPHORUS. (Cynodontium Schimper).

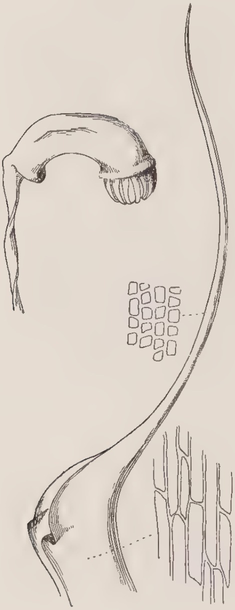


FIGURE 24.

Capsule × 13, leaf × 10, and leaf cells × 200, of *Oncophorus Wahlenbergii.*

The species of this genus are as a rule alpine or subalpine, but one of the number,

O. WAHLENBERGII Brid. is frequent enough to warrant mention here. This is a pretty little moss growing on rocks and soil in cool situations in or near the mountains. Its crisped spreading leaves, somewhat resembling *Dicranum fuscescens* in appearance, with their suddenly dilated bases, and the arcuate, smooth or irregularly wrinkled, plainly strumose capsule render it easy of recognition by one who has ever seen it before.

CERÁTODON Brid.

C. PURPUREUS (L.) Brid., our only species, is one of the commonest of all our mosses. It is found on the edges of paths, roofs of old buildings, sand by the seashore, and in general any barren compact soil is its favorite habitat. The plants are short and grow close together, forming dense thin mats of dark green. The lance-like young sporophytes appear early in spring as soon as the snow is melted. By the middle of the summer the capsules often decay beyond recognition and the seta breaks from the plant at the touch.

Unless one has become familiar with Ceratodon, it is not always easy to recognize it without mature capsules.

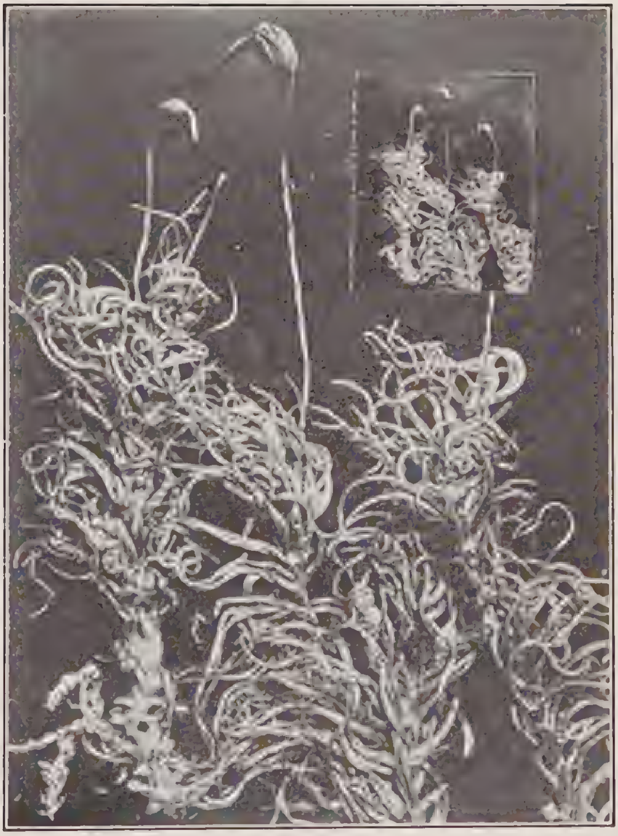


PLATE XIX.

Oncophorus Wahlenbergii, × 5. (Insert, × 1.)

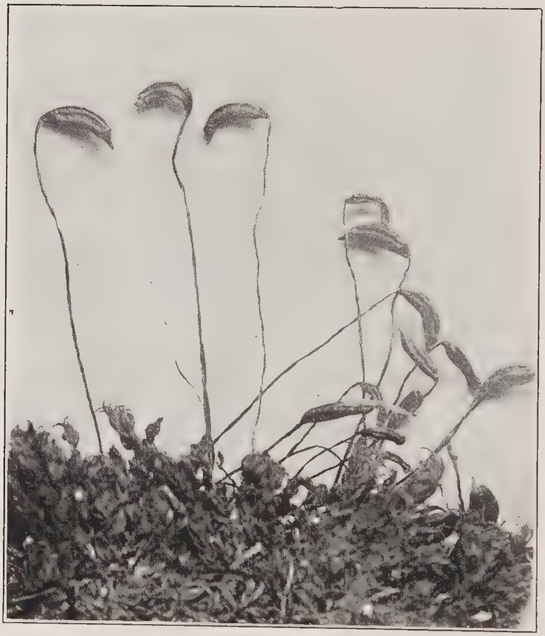


FIGURE 25.

Ceratodon purpureus, × 5, dry.

The leaves may be entire or slightly denticulate at apex, and the costa is sometimes percurrent or even excurrent. The stems sometimes become three inches long in shaded places.

When the capsules have fully matured they shrink when dry and become furrowed. This peculiar furrowing and the dark rich color of capsules, a color called purple by the older botanists but which is really a very dark chestnut or red-brown, make it easy to recognize. The peristome is shown in Plate VIII.

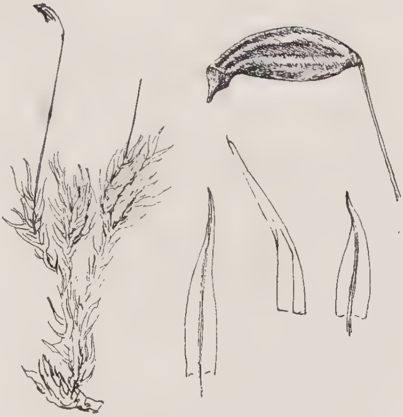


FIGURE 26.

Ceratodon purpureus, × 2. Leaves, calyptra, and capsule, × 10.

Aulacomnium palustre has a capsule furrowed in a similar manner, but it is easily distinguished by the characters noted under the description of that genus.

TREMÁTODON Mx.

T. AMBIGUUS (Hedw.) Hornsch., the Long-necked Moss, is so odd in appearance that it will need little description. It is not common, but will be met with occasionally in rather dry soil in copses and old fields where the grass is thin. Besides the long neck, *the bright yellow setae*, closely resembling those of *Ditrichum pallidum*, are an additional aid in identification. The capsules mature in summer.

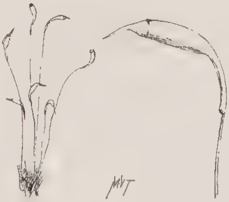


FIGURE 27.

Trematodon ambiguus, × 1, and capsule, × 5.

T. LONGICOLLIS Mx. is easily distinguished by its much longer neck, *twice the length of the rest of the capsule*, which is more cylindric than in *T. ambiguus*. Moist clayey or sandy soil in the southern part of our range and southwards.

DICRANÉLLA.

Plants small, like miniature *Dicrana*, scarcely branched. Leaves lanceolate-subulate, without specialized angular cells. Capsule short, erect or inclined, frequently striate; lid beaked; peristome dicranoid, of 16 teeth, cleft to the middle into two filiform divisions.

The small size and narrow silky leaves, narrowed gradually or abruptly from a broader base to a channelled subulate apex, render the genus easy of recognition, especially if the dicranoid capsule be present. The capsules present variations similar to those of *Dicranum*, but capsules that remain erect and symmetric when dry and empty are rare; dioicous.

KEY.

1.	Seta yellowish, sometimes becoming dark with age..	2.
	Seta red....................................	3.
2.	Capsule oblong, tapering at the neck, sulcate, mouth incurved when dry..........................	*heteromalla.*
	Capsule oblong, tapering at the neck, scarcely plicate, mouth erect when dry.......................	*heteromalla orthocarpa.*
	Capsule gibbous, strumose at neck, smooth when dry.	*cerviculata.*
3.	Leaves scarcely secund, not pellucid............	*varia.*
	Leaves secund or erect, pellucid by reason of very large thin-walled cells........................	*rufescens.*

D. HETEROMALLA (L.) Schimp. is our only common species. It is found on shaded, sandy banks throughout our range. The plants are simple or forked, one-half inch to two inches in height, and grow in dense tufts or sheets of various shades of green from bright yellowish to dark. The leaves are falcate-secund, gradually narrowed from the base so that the lower portion of the leaf has a triangular form; the upper part is subulate, and channelled with costa percurrent or excurrent. The seta is *yellow*, becoming dark with age; capsule oblong to oblong-ovoid, suberect, typically slightly curved, brown when dry and empty, and furrowed and *constricted below* the mouth *with the mouth oblique in a very characteristic manner;* operculum rostrate, oblique.

The obliquity of the mouth and the deepness of the furrows in the capsule walls seem to be progressive with age. The capsules mature in November and December, but do not as a rule appear to assume their characteristic pose until spring. This fact accounts for some of the discrepancies in descriptions, especially of the varieties, although the species as a whole is exceedingly variable.

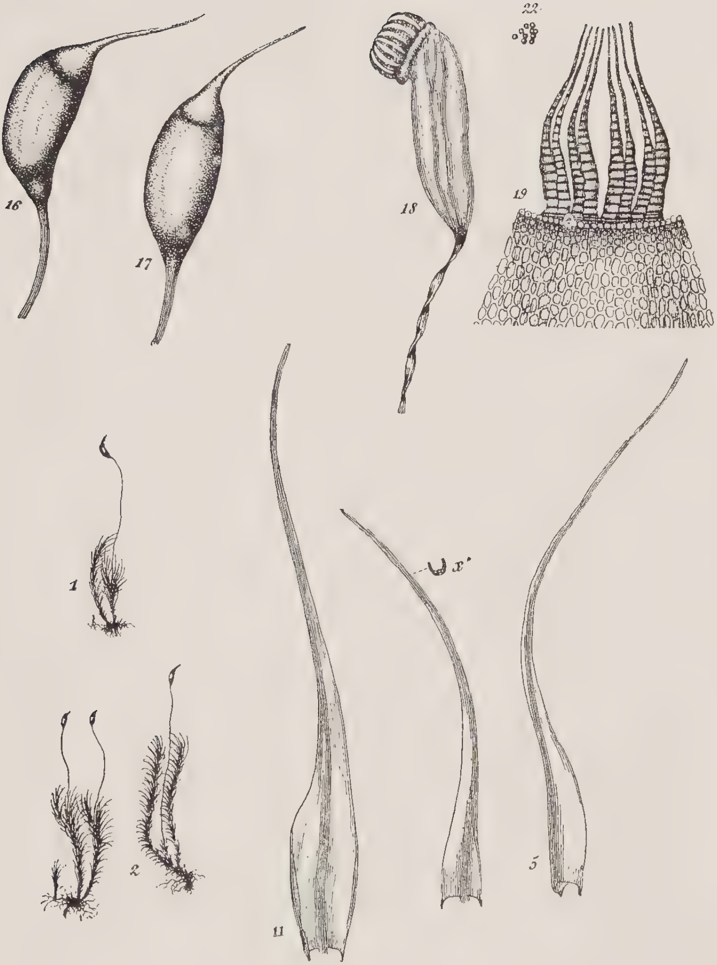


Plate XX.

Dicranella heteromalla (L.) Schimp (From Bry. Eur.). 1 and 2. Plants natural size. 5. Leaves. 11. Perichaetial leaf. 16 and 17. Capsules. 18. Dry capsule with mouth oblique. 19. Peristome. 22. Spores.

The variety ORTHOCARPA (Hedw.) E. G. B. is a form with erect straight capsules and, as I have learned recently, was described from plants collected in Lancaster, Pa., instead of being an inhabitant of elevated inland regions. The capsules, however, appear to become curved and furrowed with age.

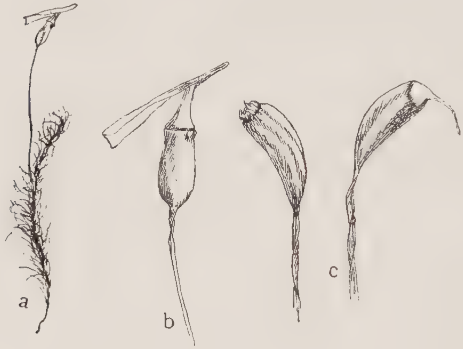


FIGURE 28.

a. Dicranella heteromalla orthocarpa. *b.* Capsule of the same, × 10. *c.* Capsules of different ages.

Var. *Fitzgeraldii* (R. and C.). I now agree with Mrs. Britton, in making this a synonym of var. *orthocarpa*, as it appears to be a southern and seaboard form, being very abundant about New York City. The capsules are only lightly striate until very old, and the mouth is slightly or not at all oblique. It has been found along Lake Champlain and may occur near the Great Lakes.

In the Bulletin of the Torrey Botanical Club for November, 1895, Mrs. Britton describes and figures a very interesting mountain form with pedicels strongly curved backwards, which straighten in drying so as to assume the normal form.

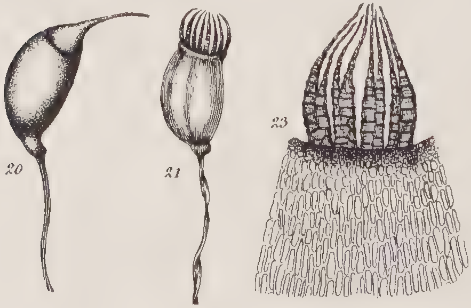


FIGURE 29.

Capsules and peristome of *D. cerviculata* (From Bry. Eur.).

D. CERVICULATA (Hedw.) Schimp. grows in wet places, typically on peat. It appears to be rare. The plants are smaller in every way than the last, the leaves are *less falcate, with a half-sheathing base,* *often nearly entire; capsule arcuate and gibbous, with a clearly strumose neck.* The spores mature in summer, according to European authors.

D. RUFESCENS (Dicks.) Schimp. The *smallest of our species, less than 1-3 in. high and very slender.* Plants usually simple, yellowish green or reddish green, turning *more strongly reddish in drying;* leaves small, *pellucid by reason of the large thin-walled cells,* linear-lanceolate, gradually narrowed; costa percurrent but not excurrent; *margin plane,* denticulate above; capsule erect or inclined, *symmetric,* oval, small, urn about 1-32 inch long; *seta and capsule dark red,* seta *twisted to the left;* operculum short-rostrate to apiculate; spores maturing in summer. Not infrequent on bare moist earth, especially on clayey soil.

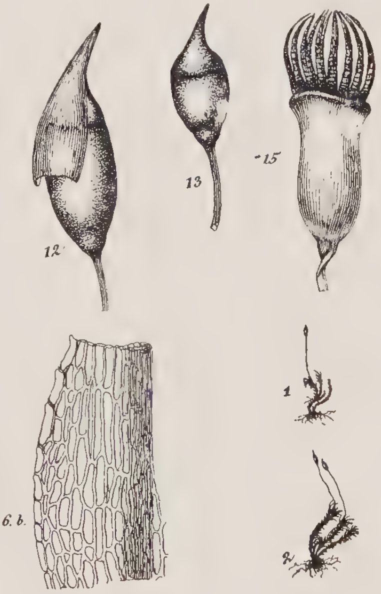


FIGURE 30.

Dicranella rufescens (From Bry. Eur.). 1 and 2. Plants natural size. 6b. Portion of base of leaf.

The seta of *D. heteromalla* and its varieties is twisted to the left and sometimes becomes very dark, so that forms of var. *orthocarpa* may be mistaken for *D. rufescens* unless one has specimens for comparison. But *rufescens* is very much smaller and more slender, and the leaf-cells are so large and pellucid as to strike one's attention at once.

D. VARIA (Hedw.) Schimp. is a somewhat similar species with a similar habit, but rather less frequent. It is larger, bright or yellowish green, not *reddish,* with short, usually *branching stems.* The leaves are entire with margins *narrowly revolute;* the capsule is larger and *curved,* the seta *twisted to the right;* spores maturing in autumn and winter.

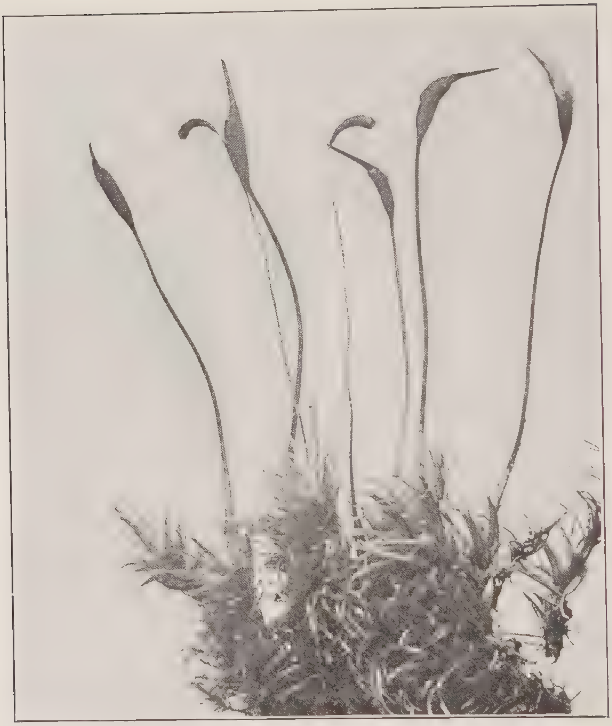


FIGURE 31.
Dicranum scoparium, about × 2, showing the sporophytes for 3 successive years.

DICRÀNUM.

The Dicranums have leaves that are narrowly to broadly lanceolate with lower cells rectangular, *angular conspicuously dilated.* The capsules are on straight erect setae, erect or inclined; teeth red, cleft half-way into two or occasionally three segments. (See Plate VIII).

The Dicranums of our region are one of the most common and beautiful elements in woodland scenery. They are, for the most part, bright yellow-green and grow in wide thick tufts or mats. The leaves are frequently more or less secund, as though the wind had blown them all in one direction. They are common on the ground, stones, rotten wood, and sometimes they occur on the base and trunks of trees. Most Dicranums mature their spores in autumn, but more observations are needed to give exact dates for each species.

There are eighteen or twenty species of Dicranum within our range, but only seven are common enough for treatment here. These seven are best treated in three groups. The first group contains two species with single curved capsules, the Broom Moss and the Fuscous Dicranum.

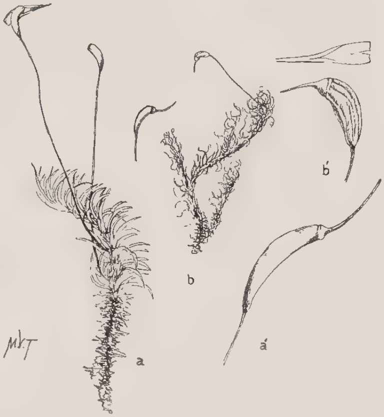


FIGURE 32.

a. Dicranum scopărium, × 1. *a′. Capsule,* × 5. *b. D. fuscescens,* × 1. *b′.* Capsule and calyptra, × 5.

The second group contains two species with curved clustered capsules and undulate leaves, the Wavy Dicranum and Drummond's Dicranum.

In the third group are three species with single erect capsules, the Flagellate Dicranum, the Fulvous Dicranum, and the Long-leaved Dicranum.

D. SCOPARIUM (L.) Hedw., the Broom Moss. The plants are large, sometimes four inches in height, and grow in rather dense tufts on decayed wood, stones or soil. The lower part of the stem is usually covered with a dense felt of radicles. The leaves are falcate-secund but not undulate or crisped. The capsules are curved but are not plicate or striate when dry except in a rather rare variety which has the capsules slightly striate. The spores mature in late summer or autumn.

The Broom Moss gets its name from its resemblance in miniature to a hair broom or counter brush. It is almost as common and widely distributed as the Common Hair-cap, being found in all portions of the northern hemisphere. It is often used by florists to form banks of green in show windows.

D. FUSCESCENS Turn., the Fuscous Dicranum, is a smaller plant yet frequently larger than the figure. The leaves are strongly crisped when dry and the capsules when dry are plainly striate or sulcate. It usually grows on decayed wood in cool moist woods at an elevation of 1000 feet or more, but may be found on soil or bases of trees, and occasionally at lower altitudes. The differences between this species and the last are well shown in the figures.

D. UNDULATUM Ehrh., the Wavy Dicranum, is very robust, 3 to 10 inches high, often decumbent at base; growing in loose wide tufts, densely radiculose, bright glossy yellow-green. The *leaves are undulate, with a silky luster*, very long, lanceolate, gradually narrowed, scarcely secund, margin recurved below for 1-3 to 1-2 the length of the leaf, above this strongly serrate to apex. The costa is comparatively narrow, with *two strongly serrate lamellae on the back above.* The alar cells are distinctly marked. *The capsules are clustered* (several setae from the same perichaetium) and the setae are long and reddish. The capsules are cernuous and arcuate, striate when empty, with spores maturing in late summer.

Our largest and most beautiful species, common in shaded places on soil and stones covered with humus, but not fruiting freely. The only species with which it could possibly be confused is the next.

D. DRUMMONDII Muell., Drummond's Dicranum, is most likely to be mistaken for *D. undulatum*, but it is rather smaller and less glossy; its leaves are less undulate and are secund and *strongly crisped;* not recurved at base below; they are much more slender pointed than in the Wavy Dicranum. The capsules of the two species are very much alike.

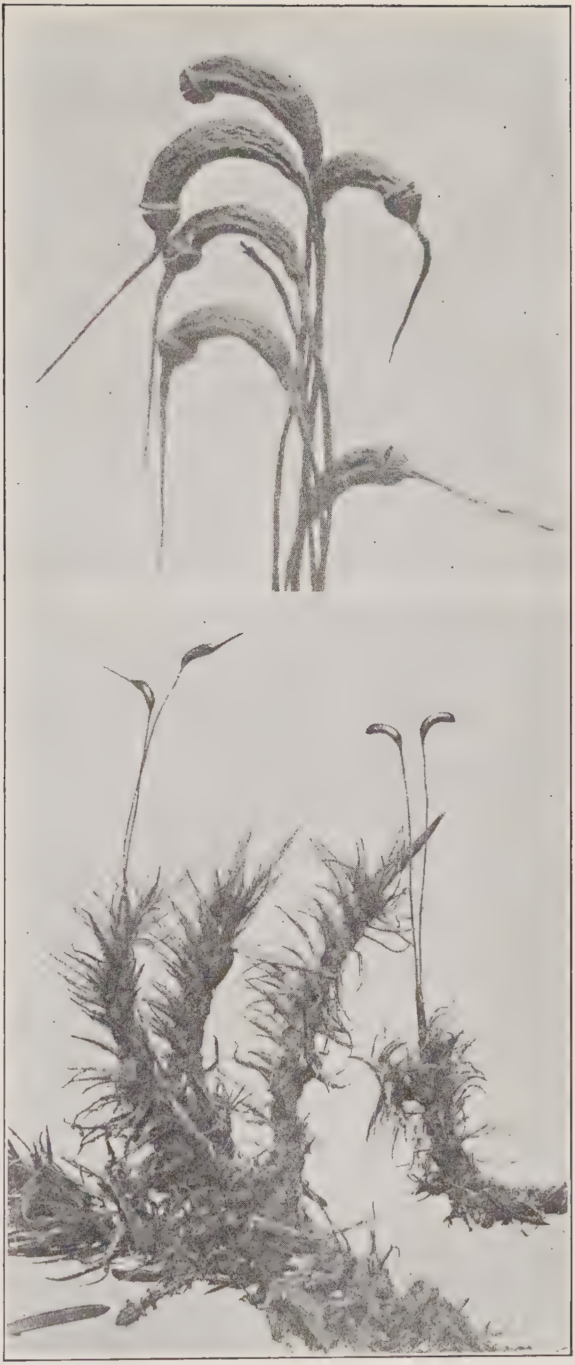
The spores mature in summer. It grows on decayed wood in forests in elevated regions, not common.

D. LONGIFOLIUM Ehrh., the Long-leaved Dicranum. This species grows only in rocky elevated regions, sometimes found on the base of trees as well as on the surrounding rocks. The leaves are very long and narrowly acuminate so that the *leaf apices look*

PLATE XXI.

(On next page.)

Dicranum undulatum, × 2. Above, capsules, × 9.



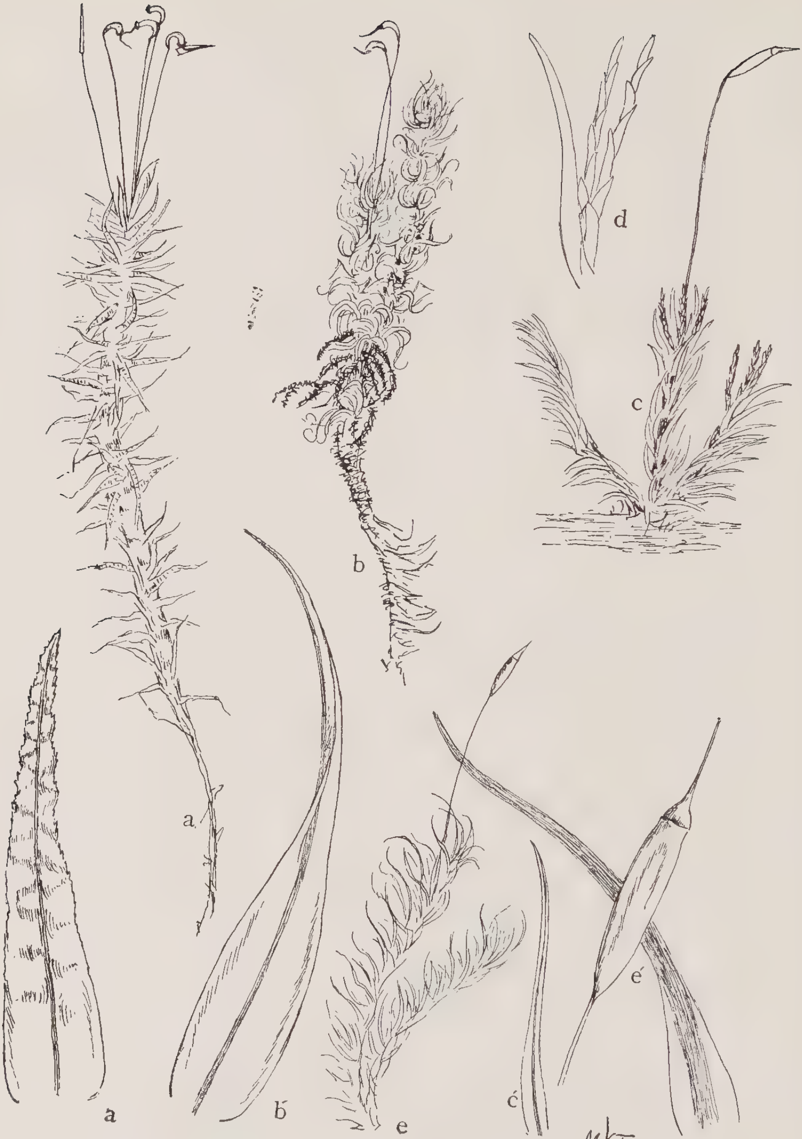


PLATE XXII.

a. Dicranum undulatum, × 1. *a′. Leaf*, × 8. *b. D. Drummondii*, × 1. *b′. Leaf*, × 8. *c. D. flagellare*, × 2. *c′. Leaf*, × 10. *d. Flagella*, × 10. *e. D. fulvum*, × 2. *e′*. Leaf and capsule, × 10.

somewhat like hairs, giving the plant a silky appearance, secund but scarcely crisped when dry, with costa more than ½ *the width of the leaf at base.* A little above the base *the leaves are suddenly narrowed and in the upper part of the leaf nothing but costa is left for the rest of the length of the leaf.* The capsules are cylindric and smooth; the spores mature in summer. (Pl. XXIII.)

DICRANODONTIUM LONGIROSTRE is a moss very closely resembling this species when without capsules, but the setae are very long and curved so that the capsule is sometimes almost pendent.

D. FLAGELLARE Hedw., the Flagellate Dicranum (Pl. XXII) has slender branchlets (flagella), with minute leaves, which give it its name. It is one of our most common species and by reason of its *crisped leaves* and *narrow costa* is not likely to be confused with any of its group. The flagella are very characteristic when present. It grows on decaying wood and peaty banks in moist shady places everywhere.

D. FULVUM Hook., the Fulvous Dicranum (Pl. XXII). This is the only other common *Dicranum* with erect capsules. It is *fulvous brown* in color, *almost always growing on rocks.* The leaves are secund, somewhat crisped when dry, gradually narrowed from a lanceolate base to an almost linear apex; margin serrate in the upper 1-5 to 1-4. *The costa is at least 1-3 the width of the leaves at base,* somewhat excurrent, toothed at back, with the apices much more slenderly tubulose than in *D. flagellare.*

The Flagellate and Fulvous Dicranums need never be confused, for the former grows on rotten wood or peaty banks, while the latter almost always grows on rocks.

The Fulvous Dicranum is distinguished from the Long-leaved by its color, its shorter leaves, and by growing at lower altitudes in more shaded, less exposed localities.

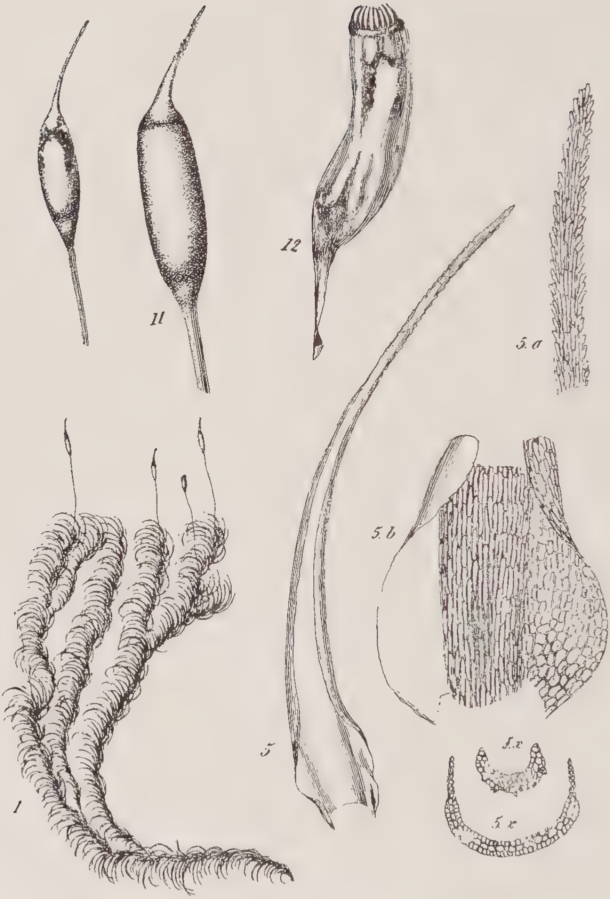

11
12
5.a
5.b
5
1
5.x
5.x

PLATE XXIII. *Dicranum longifolium* (From Bry. Eur.).

1. Plant, natural size. 5. Leaf. 5 a. and 5 b. Leaf apex and base. 5 x. Cross sections of leaf. 11 and 12. Capsules.

LEUCOBRỲUM.

L. GLAUCUM (L.) Schimp., the White Moss, Cushion Moss. Any one accustomed to walk in the woods must have noticed the grayish-white tufts of the White Moss, looking like gigantic pincushions.

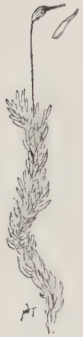


FIG. 33. *Leucobryum glaucum*, × 1.

This moss does not fruit freely, but by searching in moist woods the sporophyte can usually be found without a great deal of trouble. It matures from September to June.

The White Moss prefers moist or even swampy woods, but is often found in drier situations. The plants grow densely packed together, those in the center continually elongating and new plants being added around the edges of the tuft. The White Moss resembles the Peat Mosses in color, and the cushion-like tufts take up and retain water in the same sponge-like way.

Braithwaite states that this species often produces on the upper leaves of the female plants, minute tufts of "radicular tomentum" with young plants which fall off and serve to reproduce the plant, which produces spores rather infrequently. The amount of rainfall has apparently some influence on the spore production of this species, for I have noticed that it produces spores with unusual abundance after an especially wet summer. (Pl. XXIV.)

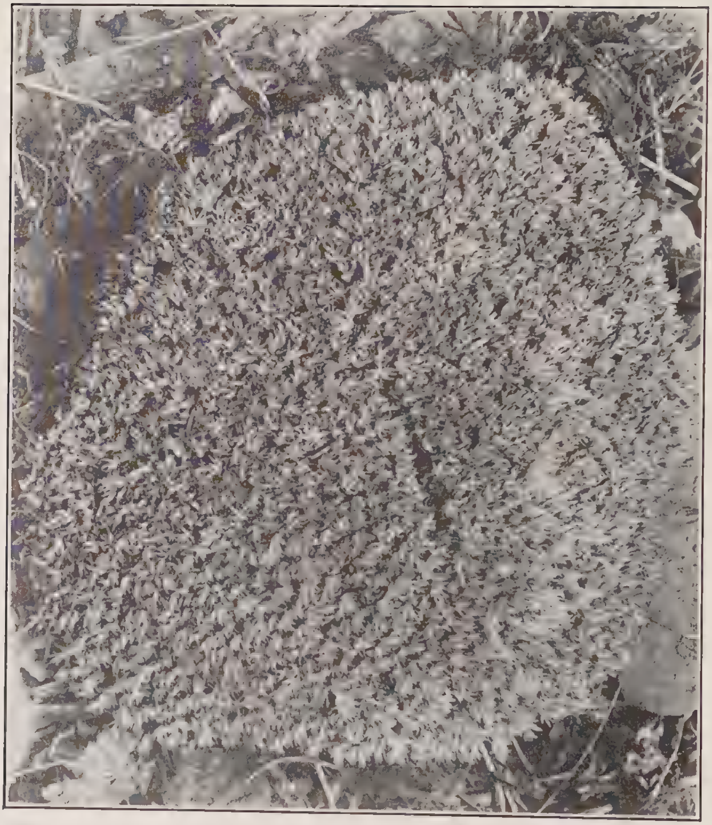


Plate XXIV.

Leucobryum glaucum.

FAMILY 8. GRIMMIACEAE. The Grimmia Family.

For a long time most members of this family seemed too difficult to study with a hand-lens, but nearly all the more common forms can be distinguished if one knows what to look for as characteristic of each species. The plants grow in tufts or mats and almost *always grow on rocks*. They are dark-brown or blackish, often green at the surface of the tufts where the young growing portion of the plant is. In many plants the leaves end in a whitish hairlike point that gives the plants a gray or hoary appearance. It is of great importance in determining the species to find out whether the margins of the leaves are plane or recurved when dry, and this can readily be made out by a careful examination with a hand-lens in a strong light. In appearance the plants of this family are much like those of the Orthotrichum Family, but in the Grimmia Family the calyptra is never hairy; the capsules are smooth when dry or at most irregularly wrinkled; the peristome single with the 16 teeth sometimes spreading but never reflexed, often forked, but never united in pairs; leaves never crisped (except Ptychomitrium). In the Orthotrichum Family the calyptra is often hairy, the capsules are nearly always deeply plicate when dry with 8 or 16 regular folds; the peristome is double, though the segments are often very narrow; the 16 teeth are often united in pairs, and nearly always strongly reflexed when dry, sometimes bending so far back as to touch the capsule wall; and the leaves are often crisped, although not so in the genus Orthotrichum. With few exceptions the plants of the Orthotrichum Family grow on the trunks of living trees.

Two species (*Orthotrichum anomalum* and *Ulota Americana*) of the Orthotrichum Family grow on rocks, both have hairy calyptras and a double peristome. Some species in both families lack the peristome. Some species of Andreaea when sterile are hard to distinguish from this family, but nearly all are subalpine. Farther distinctions are found under Andreaea.

KEY TO THE GENERA.

Leaves crisped, without whitish tips, costate; capsules long exserted....................	*Ptychomitrium.*
Leaves not crisped, with whitish tips and no costa; capsules immersed....................	*Hedwigia.*
Leaves not crisped, costate, whitish tips present in some forms, absent in others; capsules immersed or exserted....................	*Grimmia* and *Rhacomitrium.*

HEDWÍGIA

is named for Hedwig, one of the best bryologists of the eighteenth century.

H. ALBICANS (Web.) Lindb. (*H. ciliata* Ehrh.) is our only species. It is common on boulders, ledges, stone walls, and on dry exposed places. The plants vary a great deal in size, but in general have much longer stems and branches than their relatives, besides being much the most common of all the family.

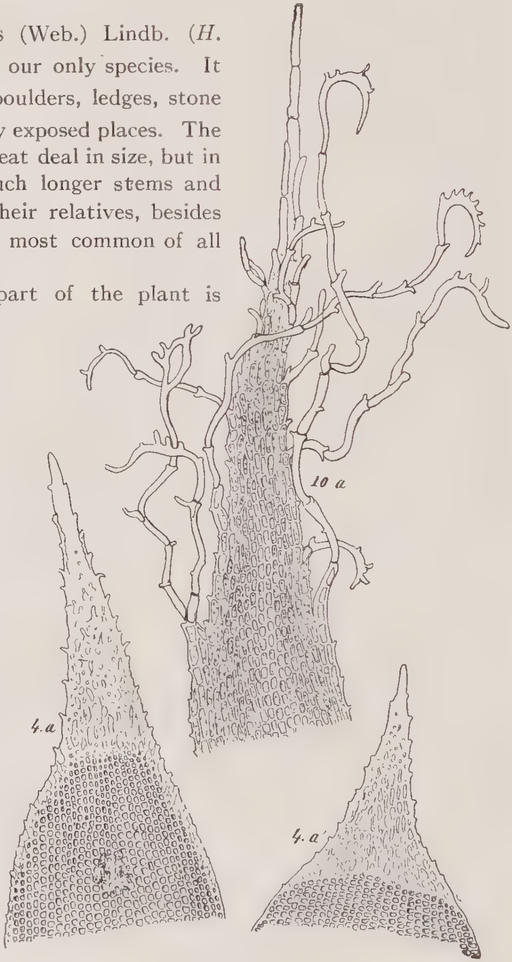


FIGURE 34.

4*a* and 4*a*′. Apices of leaves of *Hedwigia albicans*. 10*a*. Apex of perichaetial leaf (From Bry. Eur.). See also Frontispiece.

The lower part of the plant is brown or black, the upper green, with a tinge of gray due to the colorless tips of the leaves. The perichaetial leaves are ciliate along their upper margins as shown in the cut. There is no costa in any of the leaves, and no peristome, both of which characters are rare in this family. The capsules are entirely concealed in the longer more slender perichaetial leaves, and the only indication of their presence is a slight enlargement of the ends of some of the branches. The capsules are almost spherical, with a clear-cut lid and no peristome; they mature in spring.

An attempt has been made to illustrate the remarkable transformation that these plants undergo when moistened, but no drawing can do justice to the magic of the change.

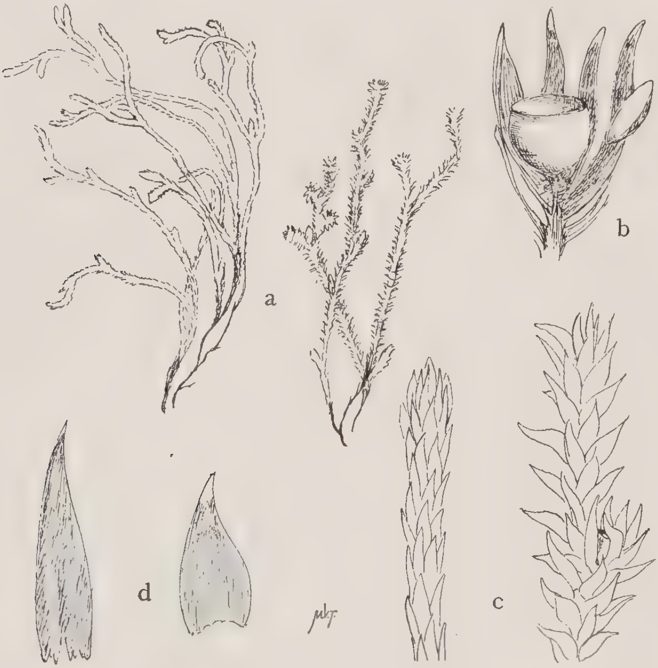


FIGURE 35.

Hedwigia albicans, a, × 1, dry and wet. b, Capsule with a portion of the perichaetial leaves removed, × 10. c, Branches, × 5, dry and wet. d, Leaves, × 10.

PTYCHOMÍTRIUM.

This genus is rare in most parts of our range and only one species is likely to be found.

P. INCURVUM (Schwaegr.) Sulliv. The plants of this species are about ¼ inch in height (½ inch with fruit) and grow on granitic

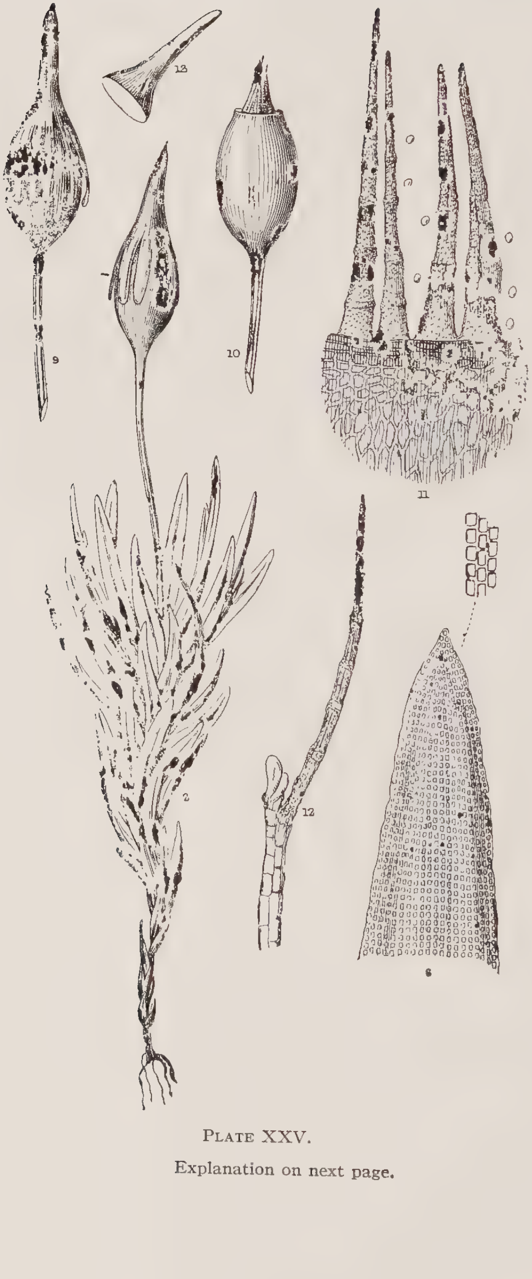

13
9
10
11
2
12
6

Plate XXV.

Explanation on next page.

rocks from Connecticut southwards. The leaves are crisped and without whitish hair points; the calyptra is mitrate, plicate and without hairs; the operculum is long-beaked; the capsule nearly smooth when dry, and the peristome teeth are slender. The spores mature in winter or early spring.

The crispate leaves remind one very strongly of *Ulota* and indeed it is most likely to be mistaken for a member of that genus so far as general appearance goes, but its habitat on granitic rocks and its long beaked operculum, scarcely striate capsule and single peristome of slender teeth will easily differentiate it.

GRIMMIA AND RHACOMITRIUM

are so much alike, except in microscopic characters, that it will be much more convenient to treat them together. The family description will answer for these genera.

KEY TO THE SPECIES.

1.	Capsule exserted or at least shorter than the seta	2.
	Capsule immersed, longer than the seta	5.
2.	Seta strongly curved; leaf margins not reflexed	*G. Olneyi.*
	Seta straight; leaf margins recurved	3.
3.	Stems usually elongated and slender, bearing numerous short clustered obtuse lateral branchlets; leaves lanceolate, acute; subalpine or growing on exposed rocks	4.
	Stems stout without short lateral branchlets; leaves lingulate, broadly obtuse; growing near waterfalls and on wet rocks in cool or elevated regions	*R. aciculare.*
4.	Leaves without whitish hair tips	*R. fasciculare.*
	Whitish hair tips present on some of the leaves	*R. microcarpum.*
5.	Plants with conspicuous whitish leaf tips, columella not attached to operculum	*G. pennsylvanica.*
	Whitish leaf tips absent or inconspicuous; operculum falling with columella attached	*G. apocarpa.*

PLATE XXV.

Ptychomitrium incurvum (From Sulliv. "Icones"). 2. Plant, highly magnified. 6. Apex of leaf. 12. Side view of annulus and peristome tooth. 6 and 12 require a compound microscope.

GRÍMMIA

G. APOCARPA (L.) Hedw., the Common Grimmia, is our most common member of the family next to Hedwigia, for which it might possibly be mistaken, but it is smaller, with whitish leaf-tips scarcely visible, often lacking on many of the leaves, with leaves plainly costate and with margins strongly recurved. The peristome is well developed and plainly visible with a lens. The most distinctive character is the falling of the columella attached to the operculum. This character is best ascertained by removing the lid from a ripe capsule with dissecting needles and examining

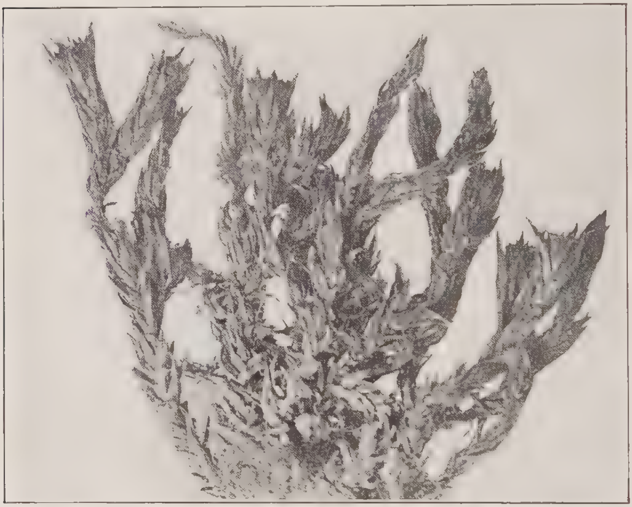


FIGURE 36.

Grimmia apocarpa, × 5.

PLATE XXVI. *Grimmia apocarpa* (From Bry. Eur.).

1, 2, 3. Plants natural size. Fig. 6a. Apex of upper leaf. Fig. 18. Operculum with the attached columella. The other figures are self-explanatory.

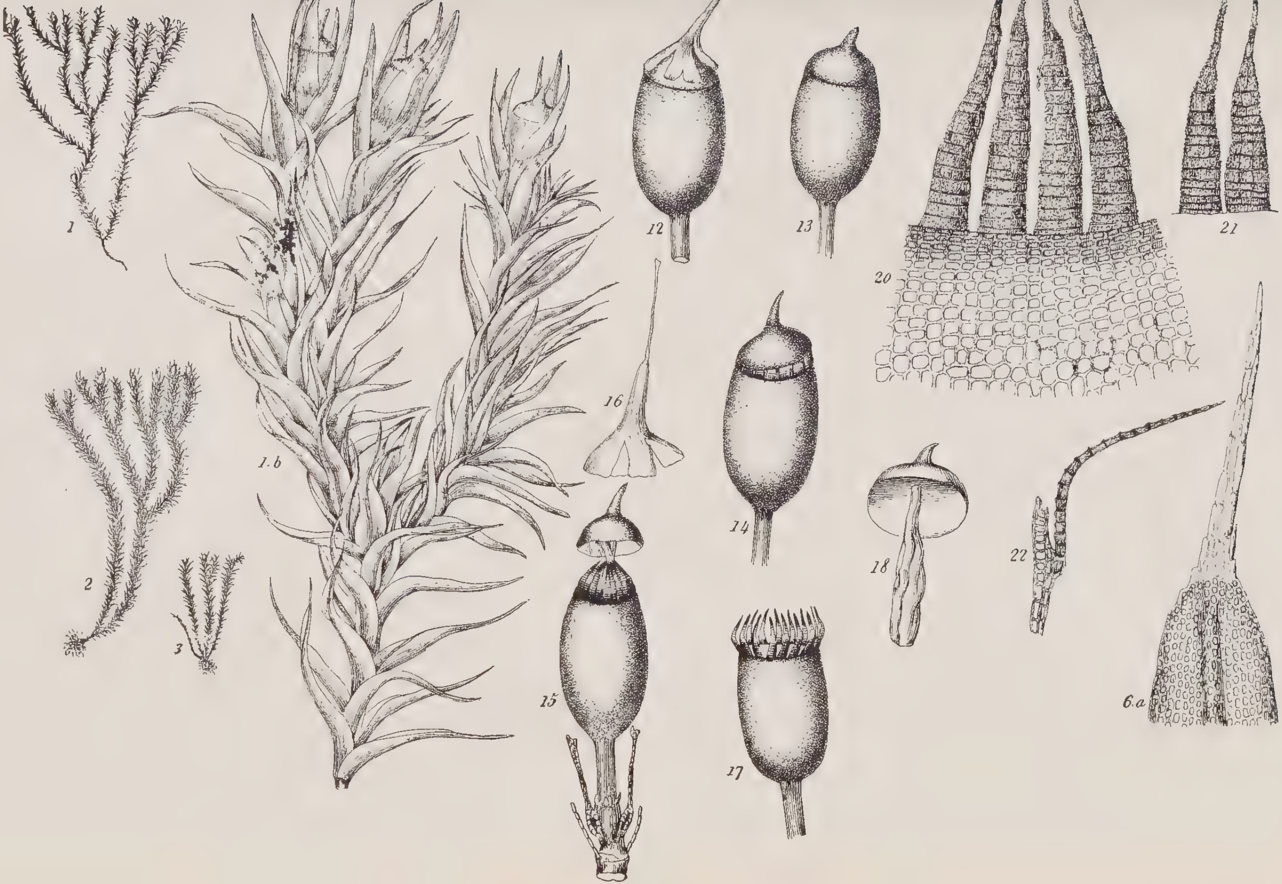

1
1.b
2
3
12
13
14
15
16
17
18
20
21
22
6.a

PLATE XXVI

with a high power lens. There are other species with this peculiarity but they are rare or local.

G. PENNSYLVANICA Schwaegr., the Pennsylvania Grimmia, seems to be our most common species next to *apocarpa*, but in the northern portion of our range it seems seldom to fruit and is apparently little collected. It is a *large coarse* dark green moss from ½ inch to 1 inch high, slightly hoary at the ends of the stems; leaves lanceolate, *appearing very dark and opaque in the upper part, margin strongly recurved*, hair-point short and rough, cells at extreme *base elongated-rectangular* and hyaline or yellowish; next above these the cells are short rectangular, as shown in the figure. The spores mature in late autumn, but operculate capsules may be found in April.

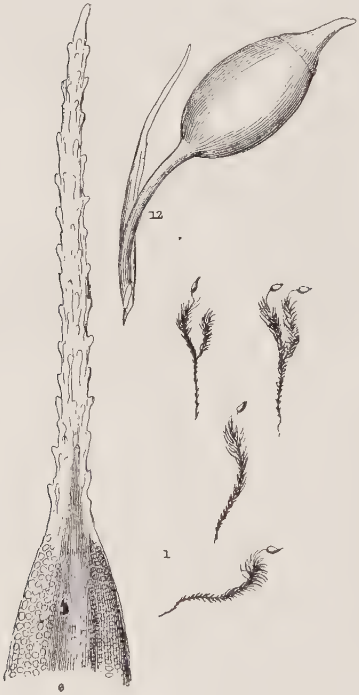


FIGURE 37.

Grimmia Olneyi (From Sulliv. "Icones"). 1. Plants natural size. 6. Leaf apex. 12. Capsule and seta.

G. OLNEYI Sulliv., Olney's Grimmia, grows in dark green tufts, blackish below, more compact and *finer grained* than *apocarpa;* stems often nearly denuded of leaves below, about 1 inch high; leaves lanceolate from an ovate base, the upper *ending in a long rough hyaline hair, margins not at all reflexed;* capsule exserted on a *curved seta;* operculum beaked; spores maturing in

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PLATE XXVII. *Grimmia pennsylvanica* (From Sulliv. "Icones").

1. Plants natural size. Figs. 15, 16 and 17. Antheridial buds, perigonial leaf, and antheridium respectively. The other figures are self-explanatory. A number of the figures require a compound microscope for their demonstration.

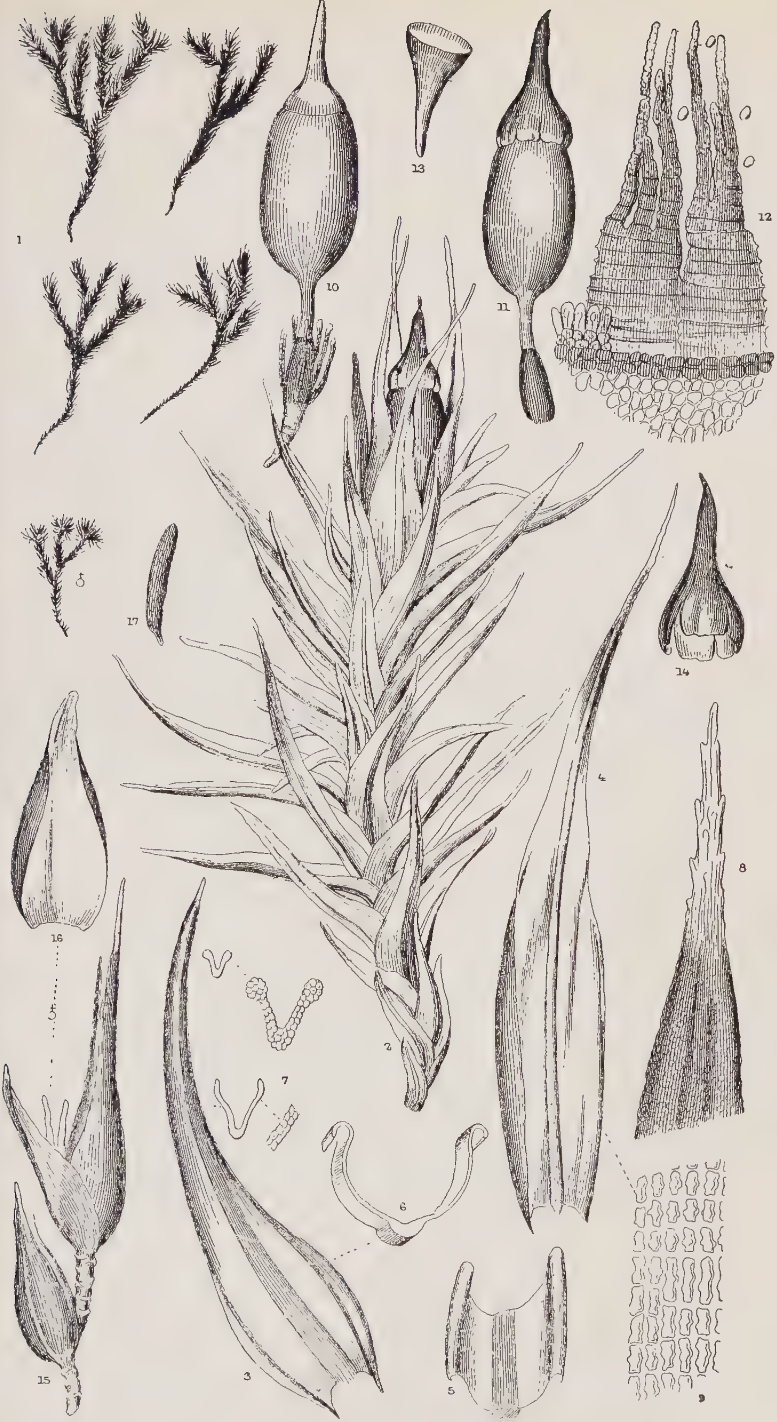

1
13
10
11
12
♂
17
14
4
16
8
♂
7
2
6
15
3
5
9

PLATE XXVII.

Explanation on preceding page.

April. On rocks, not rare in the lowlands of the central portion of our range, especially along rivers, extending north to southern Vermont. This is our only species with curved seta, and even in this some of the setae seem almost erect. In the dried specimens the capsule appears more fully exserted than is indicated in the figure. This is the only one of the species here treated that has plane leaf-margins.

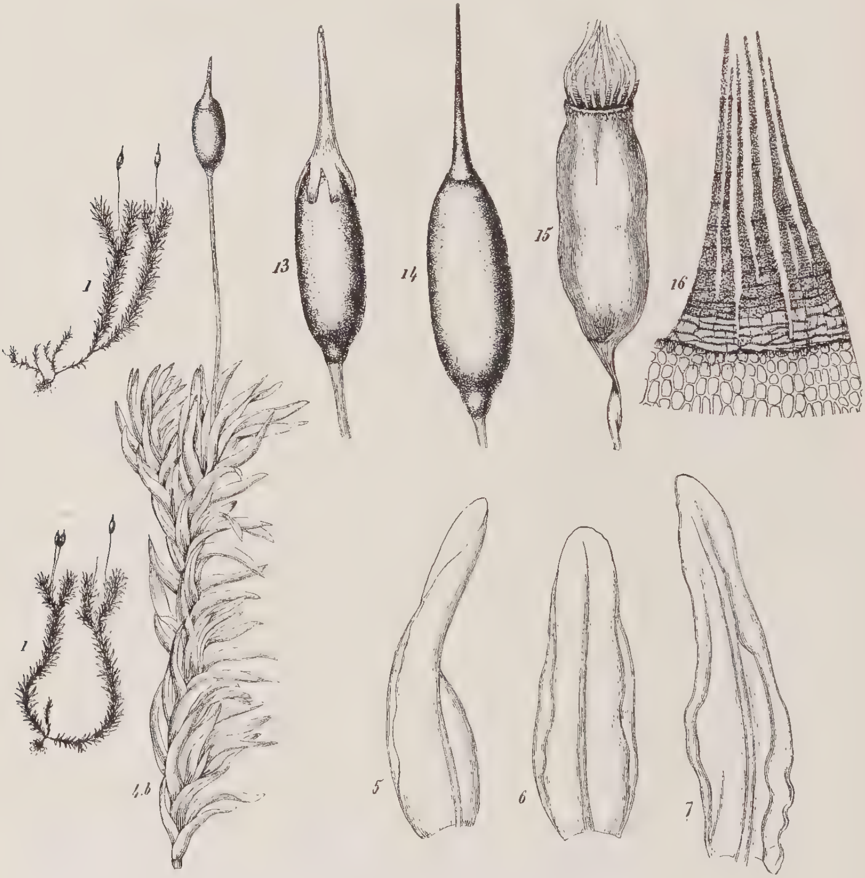


FIGURE 38. *Rhacomitrium aciculare* (From Bry. Eur.).
1. Plants natural size. 5, 6, 7. Leaves.

RHACOMÍTRIUM.

R. ACICULARE (L.) Brid. is one of our common mosses occurring around waterfalls and on wet rocks in cool and in elevated situations. Plants large, 1 to 3 inches long, and very stout; the broad leaves broadly obtuse, entire or denticulate at apex with small distant teeth, characterize this species so distinctly that no further description is needed, except that given by the plate. The leaf-characters are so distinct that this species is easily recognized with a hand-lens. The spores mature in spring, but well-developed capsules are found

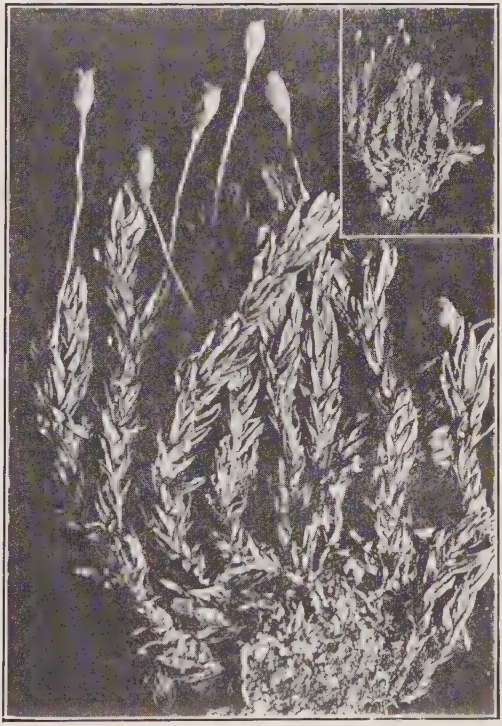


FIGURE 39.

Rhacomitrium aciculare, × 5.

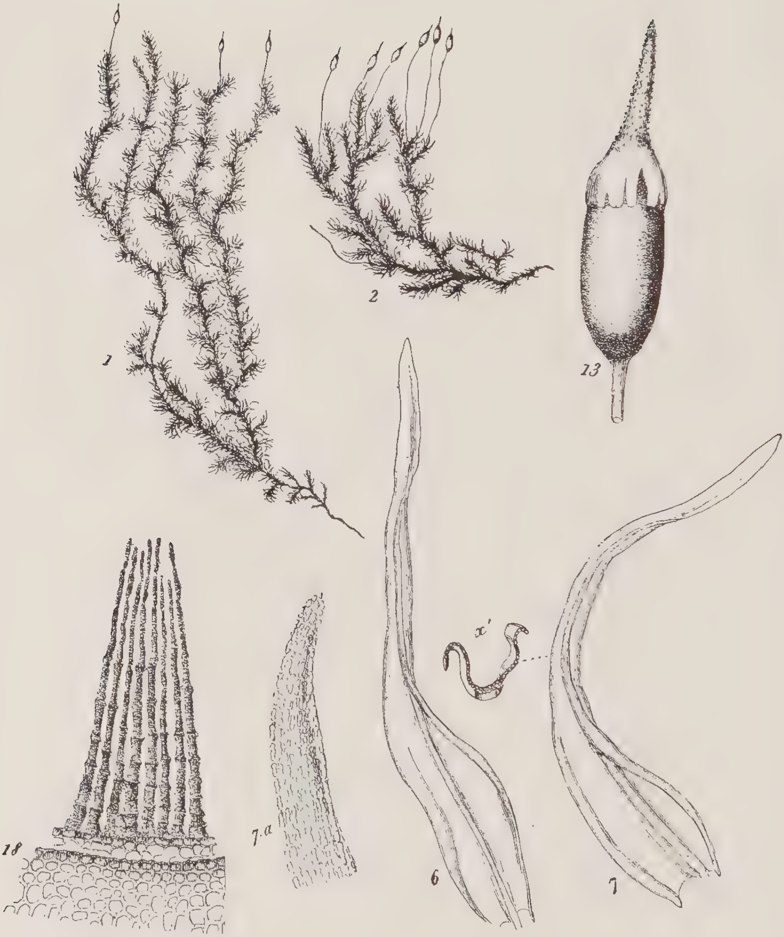


PLATE XXVIII. *Rhacomitrium fasciculare* (From Bry. Eur.).

1. Plant natural size, showing characteristic method of branching. 7a. Apex of leaf. The other figures are self-explanatory.

in autumn. In this species as well as in most others of the genus nearly an entire year seems to be needed for the complete development of the sporophyte.

R. FASCICULARE (Schrad.) Brid. grows in rather close flat patches, yellowish green above, black or brownish below, bearing *very numerous short obtuse lateral branchlets* (see Pl. XXVIII); leaves *lanceolate, nearly or quite obtuse, without hyaline point;* costa faint, vanish-

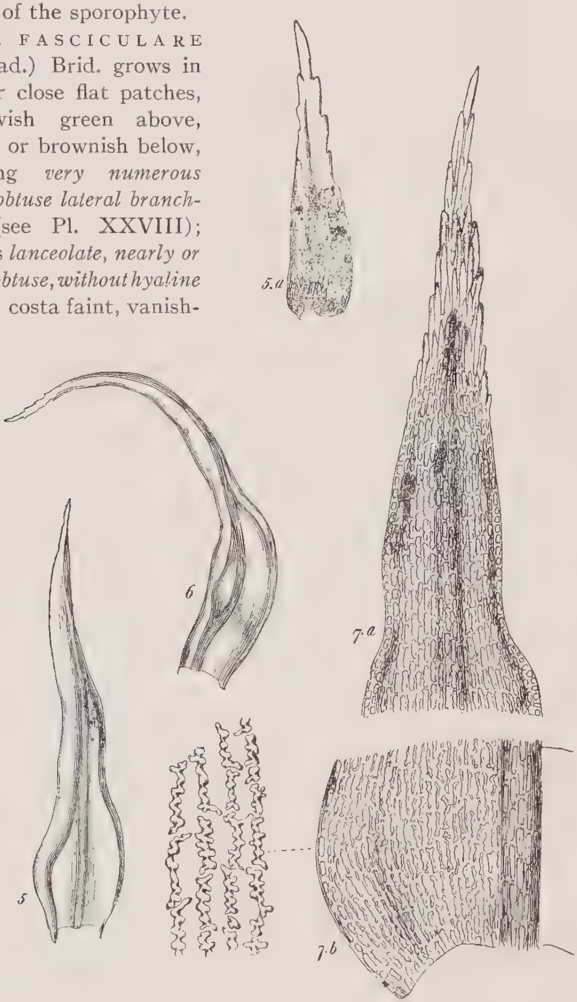


FIGURE 40.

Rhacomitrium microcarpum (From Bry. Eur.). Leaves and leaf-structure.

ing below the apex; peristome teeth divided to the base, spores maturing in spring. Most likely to be confused with *microcarpum*, but easily distinguished by the total absence of hair-points. Common in alpine or subalpine regions, but not likely to be met with elsewhere.

R. MICROCARPUM (Schrad.) Brid. resembles the last in general appearance, but with leaves shorter and having a *stronger percurrent costa* and *hyaline-tipped leaves* (in the perichaetial leaves the costa ceases below the apex and the apex is sometimes obtuse without hyaline tips, making a puzzling combination), hyaline apex of leaves denticulate; capsule smaller and lighter-colored than in the last; spores maturing in spring. Our most common species after *aciculare*, growing on exposed rocks on hills throughout our range, but apparently somewhat local. The form with obtuse perichaetial leaves which seems common in the Franconia Mountains is likely to be mistaken for *fasciculare*, unless the lower leaves be examined.

FAMILY 9. TORTULACEAE. Tortula Family.

The family name is particularly appropriate, as not only are the leaves twisted (often strongly crisped) when dry in nearly all the species, but the peristome also is strongly twisted in a large number of the genera. The family is a large one with a very great range of variation, which is partly due to the degeneracy of several of its members. The species here treated all grow on soil or crumbling moist rocks and cliffs. Nearly all are short-stemmed with radicles present at base only. The leaves in nearly every case have the basal 1-3 to 1-2 made up of thin-walled hyaline or slightly colored cells, while the upper portion is made up of minute thick-walled cells so that it appears nearly opaque. The costa is nearly always strong and often excurrent. Astomum, which is treated with Pleuridium, does not open its capsules by a lid, and Pottia, which is treated with Physcomitrium, and Gymnostomum have no peristome, but the great majority of the species have a well-developed peristome which may consist of 16 straight, slender, more or less divided teeth, or in many cases of 32 fine hairlike teeth spirally twisted in

PLATE XXIX. *Gymnostomum curvirostre* (From Bry. Eur.).

1 and 2. Plants natural size. 12. Section of capsule.

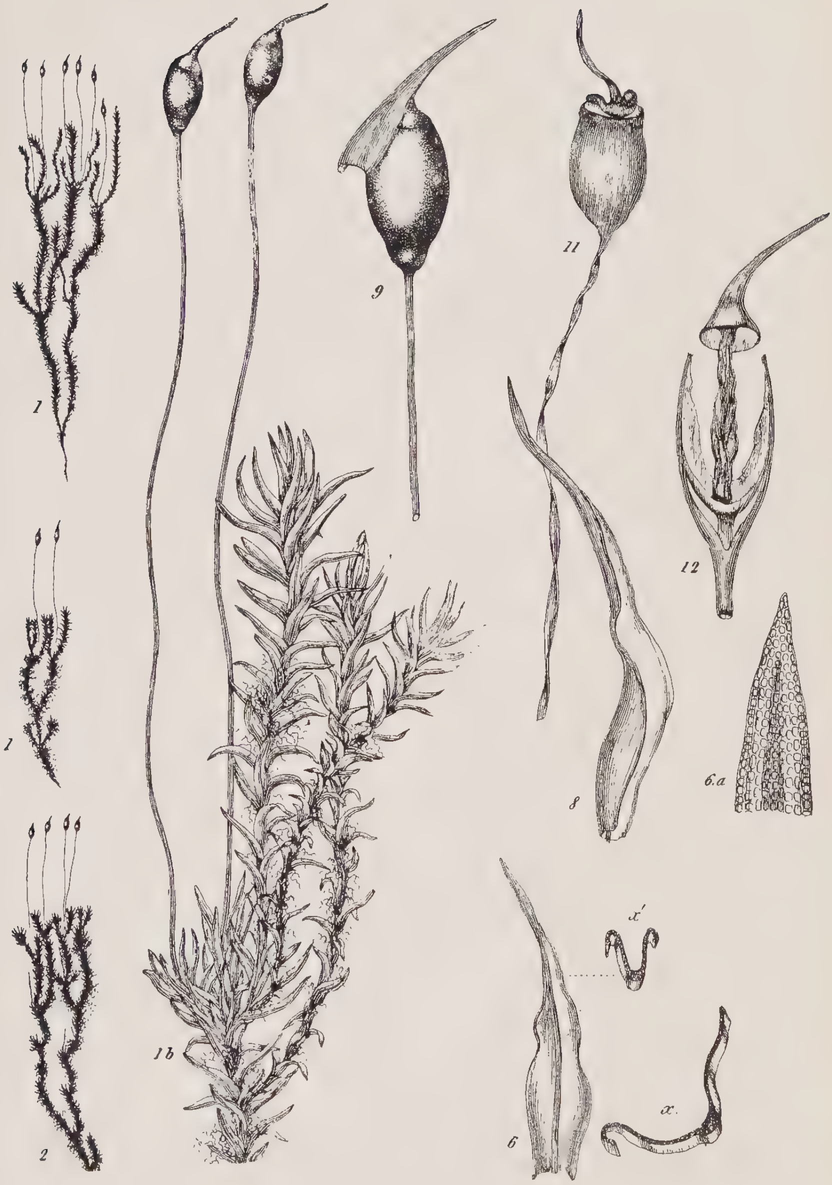

1
1
2
1b
9
11
12
8
6.a
x'
6
x.

PLATE XXIX.

Explanation on preceding page.

several turns (see Plate VII, Figs. 6, 7, and 8). The capsules are on rather long straight setae and are usually erect and cylindrical or nearly so.

KEY TO THE GENERA.

1. Leaves tapering gradually from the base to the acute apex . . 3.
   Leaves increasing in width from the base upwards, or at least not narrowed until near apex, broad in outline and rounded at apex except for the costa, which often extends out into a long white hair . . . . 2.
2. Peristome of 32 filiform strongly twisted teeth which arise from a high basal membrane (basal membrane short in *T. muralis*) . . . . *Tortula.*
   Teeth 16, short, not twisted . . . . *Desmatodon.*
3. Peristome lacking. Plants common on wet ledges and cliffs where lime is present . . . . *Gymnostomum.*
   Peristome present, operculum falling as soon as detached . . . 4.
4. Leaves curled to slightly crisped, with margins revolute; basal part of leaf usually somewhat colored; peristome twisted . . *Barbula.*
   Leaves strongly crisped when dry with margins plane or rolled inwards and base usually hyaline . . . . 5.
5. Peristome of 16 short teeth; plants small . . . . *Weisia.*
   Peristome of 32 slender twisted teeth; plants large for the family . . . . *Tortella.*

GYMNÓSTOMUM.

If you can find a wet cliff with some lime in its composition you will be almost sure to find a portion of it covered with the dense mats of *Gymnostomum* which we might call, after the manner of a well-known Flora, the Toothless Twisted Moss, as the generic name means lacking a peristome. The dense mats usually produce an abundance of small ovoid capsules which mature in autumn. The leaves are really less twisted than in any other genus of the family, hardly enough to be noticeable.

G. CURVIROSTRE (Ehrh.) Hedw. This is apparently our most common species as well as our largest. The plants sometimes reach a length of 4 inches. The leaves are scarcely twisted when dry, narrowly lanceolate, acute, with *one margin*, at least, recurved. The seta is usually longer than in the other species; *capsule dark red-brown, glossy, thick-walled,* widest at mouth when dry and empty. The *operculum remains attached to the columella after separating from the urn* and is thus attached for some time. The spores mature in late summer or autumn. (Pls. XXIX and XXX.)

This species and the next are very closely related and are often confused. If collected in autumn or winter, this species is readily distinguished by reason of the fact that the operculum remains attached to the columella after dehiscence. I have found opercula as late as May or June when the young sporophytes were beginning to appear. When moistened the capsule-walls and the operculum swell so as again to close the capsule and thus do the work ordinarily done by the peristome.

G. RUPESTRE Schleich. is distinguished from the preceding by the *broader-pointed*, *plane-margined leaves*, the shorter seta and the *thin-walled*, *yellowish-brown capsule* and by the *completely* dehiscent operculum. Spores mature at about the same time.

WEÌSIA.

The Weisias are small mosses growing in tufts or mats on soil, especially rather dry sandy soil with our species, freely branching; the upper leaves are usually much larger than the lower, erect-spreading, strongly crispate when dry, elongated-lanceolate with the costa usually excurrent into a short point; capsule well exserted on a seta of moderate length, usually erect and symmetric, ovoid, plicate when dry and empty.

W. VIRIDULA (L.) Hedw. is a species common in rather dry soil and occasionally growing in more moist situations. It is exceedingly variable in its peristome and its size. Our plants are mainly of the smaller size figured in the plate, but the capsules are nearly always erect. It may usually be distinguished from *Astomum* when sterile by its larger size and longer leaves. The margins of the leaves are so strongly inrolled above as to make them appear almost tubular. The capsules do not apparently become wrinkled as shown in the plate until they have reached a considerable age. The spores mature in spring. In Californian forms the peristome is almost entirely lacking. (Pl. XXX.)

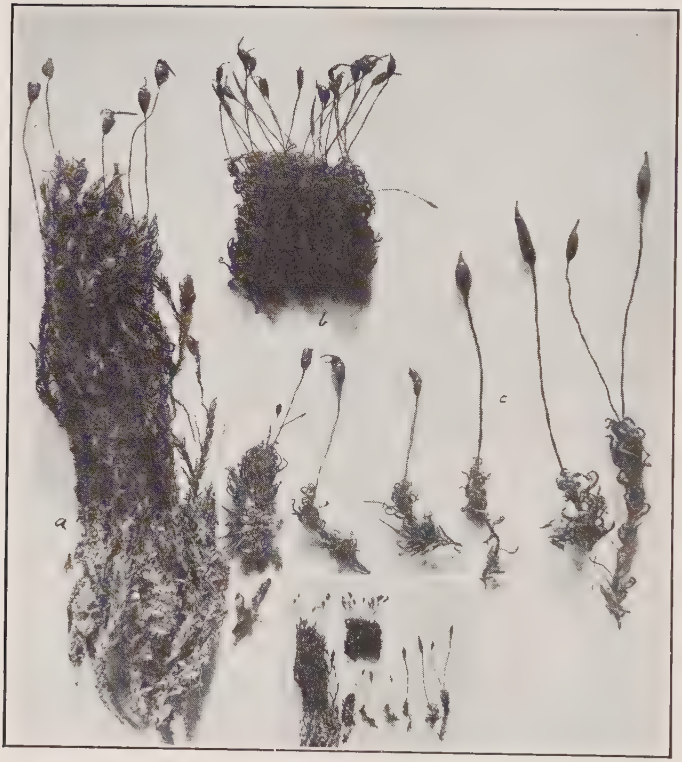


Plate XXX.

a. Gymnostomum curvirostre. b. Weisia viridula above and below *c.* Four plants of *Barbula unguiculata.* (Insert, × 1.)

BÁRBULA.

The leaves of this genus are lanceolate from a broader base (except *B. unguiculata*) and are somewhat contorted when dry but scarcely crispate, margins revolute. The costa is percurrent or barely excurrent. The capsules are nearly cylindric and the peristomes strongly twisted. Tortella and Tortula are likely to be confused with Barbula, but in Tortella the leaves are strongly crisped when dry and the transparent cells at the base run up the margin so that the boundary line between the transparent and opaque areas is in the shape of the letter V. In all our species of Tortula here described the costa is long-excurrent into a hair point.

B. UNGUICULATA (Huds.) Hedw., the Common Barbula, is our most common and most variable Barbula. The plants are green to dirty green, ¼ inch high; leaves erect-spreading or slightly recurved when moist, spirally twisted when dry, lingulate to oblong-lanceolate, obtuse. The costa is excurrent into a short round mucro; margin recurved below, but plane above. The perichaetial leaves are longer and more acute. The seta is red-brown; the capsule oblong or cylindric, usually symmetric, with beaked lid. The peristome teeth are long and slender, spirally twisted in two turns. The spores mature from late autumn to early spring. On damp earth, walls, and stones. Exceedingly variable, especially in leaf forms, which may become lance-linear, and even acute in the case of the perichaetial leaves. It might be confused with *Tortella caespitosa*, but the leaves are shorter than in that species; the margins are recurved and the hyaline basal cells do not run up the margin. In general the plants are much darker colored. (Pl. XXXI.)

B. CONVOLUTA Hedw., the Sheathing Barbula, is, next to the preceding, our most common Barbula. The plants are slender, less than ¼ inch high, densely caespitose, yellowish green. The leaves are erect-spreading when moist, crisped when dry, oblong-lanceolate to lingulate, obtuse to obtusely acute. The costa ends in or below the apex, very rarely excurrent into a minute point. The margin of the leaf is said to be slightly recurved at base, *but this character is very hard to demonstrate. The perichaetial leaves are long-sheathing, convolute, inner without costa.* The seta is ¼ to 1 inch long, slender, *straw-colored or becoming reddish with age*, and the peristome several times twisted. The spores mature in spring. On soil, especially in limestone regions, in rather dry places. (Pl. XXXII.)

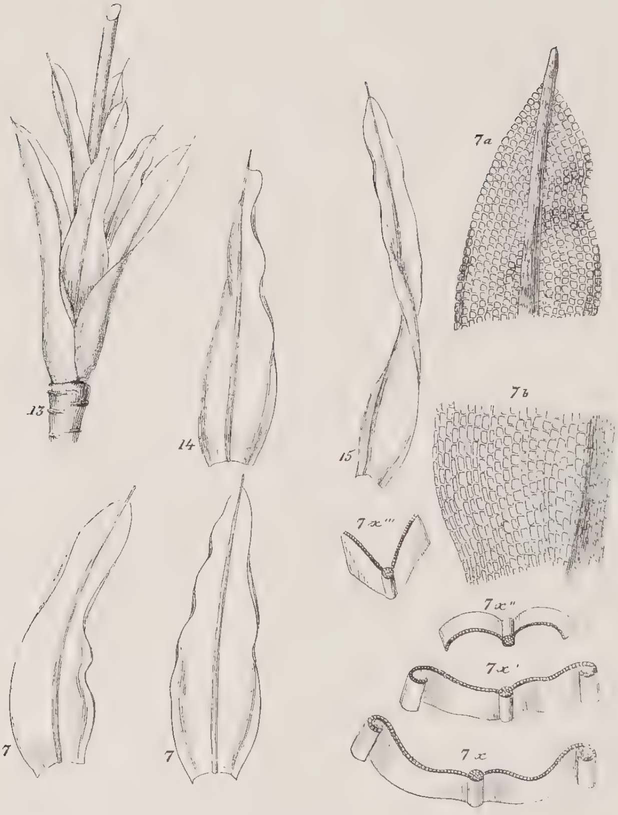

13
14
15
7a
7b
7x'''
7x''
7x'
7x
7
7

PLATE XXXI. *Barbula unguiculata* (From Bry. Eur.). 1, 2, 3. Plants natural size.

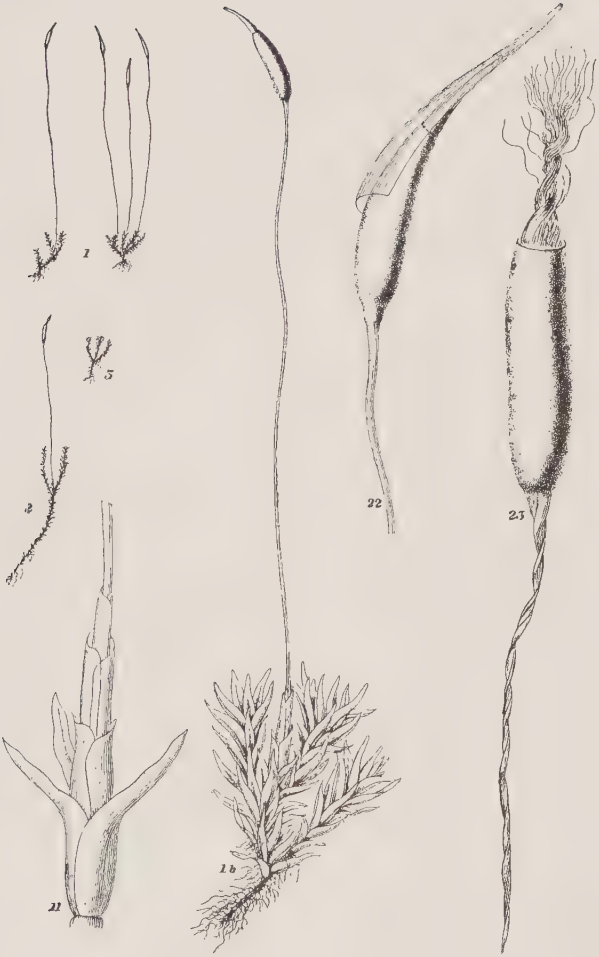

1
5
2
11
1b
22
23

PLATE XXXII: *Barbula convoluta* (From Bry. Eur.).

At first sight this species reminds one of *Ceratodon*, but the longer operculum, yellowish seta, and convolute perichaetial leaves easily distinguish it, even with a hand-lens.

TORTÉLLA.

Much like Barbula except for the differences enumerated under that genus. The plants are usually larger with longer, plane-margined leaves, and grow in denser, often densely radiculose tufts.

T. CAESPITOSA (Schwaegr.) Limpr. strongly resembles *Barbula unguiculata*, but the leaves are much longer, with plane margins and hyaline cells running up the margin. It is common on roots of trees and on soil in woods. The spores mature in spring.

T. TORTUOSA (L.) Limpr. The plants of this species are 1–3 inches in height, densely radiculose with red-brown filaments, stout, *growing in dense rounded tufts*, pale or yellowish green above, light brown below. The leaves are crowded, very long (¼ inch), *linear-lanceolate*, tapering gradually to the *slenderly acute apex*, spreading and flexuose when moist, very strongly crisped, and often spirally contorted when dry. The *costa is excurrent into a short acute point*, hyaline area at base large and extending obliquely far up the margin. The seta is ½ to 1 inch long, *red below, paler above*. The spores mature in late spring. Common on rocks, especially limestone, perhaps the most common species of the family except *Weisia viridula*, but fruiting rather infrequently. This species is of almost world-wide distribution.

The large size of the plants and the *long-linear* or *lance-linear* slenderly acuminate leaves, much crisped when dry, make the species easy of recognition.

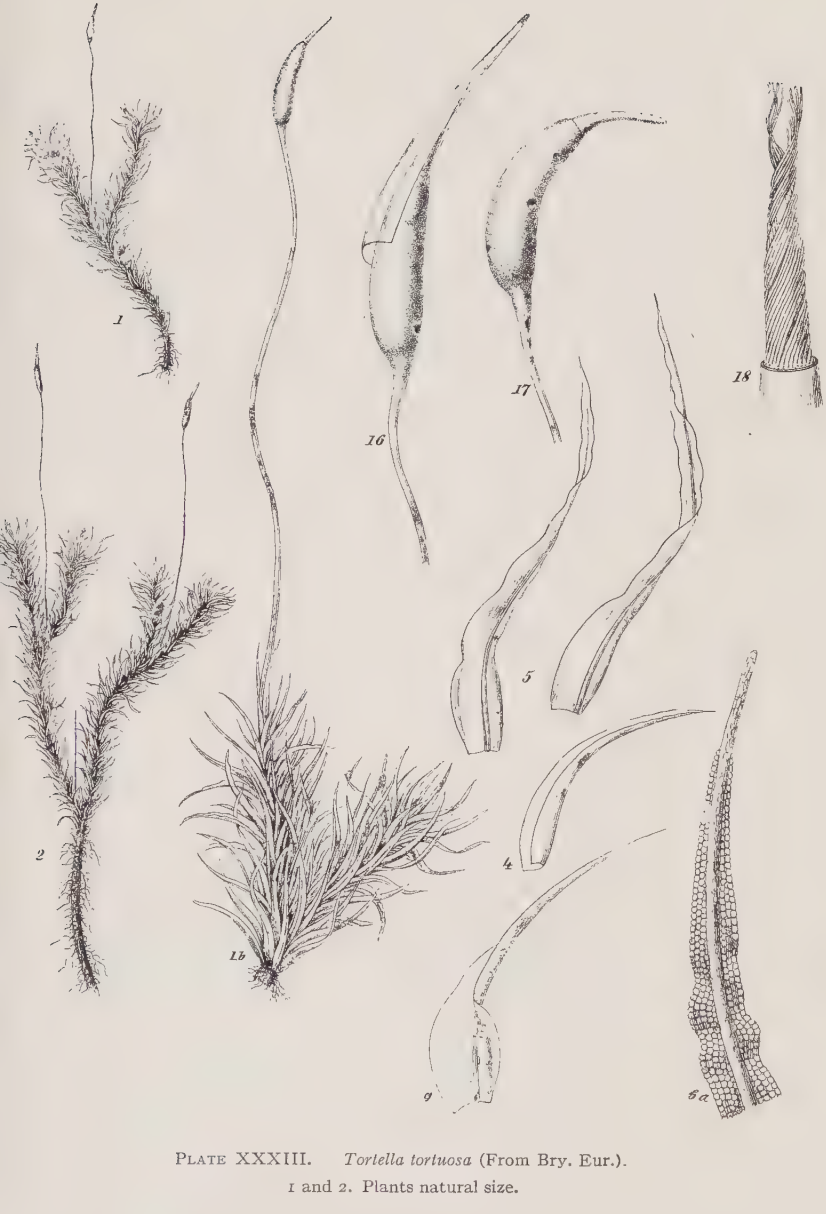

1
16
17
18
5
2
4
1b
9
6a

PLATE XXXIII. *Tortella tortuosa* (From Bry. Eur.).
1 and 2. Plants natural size.

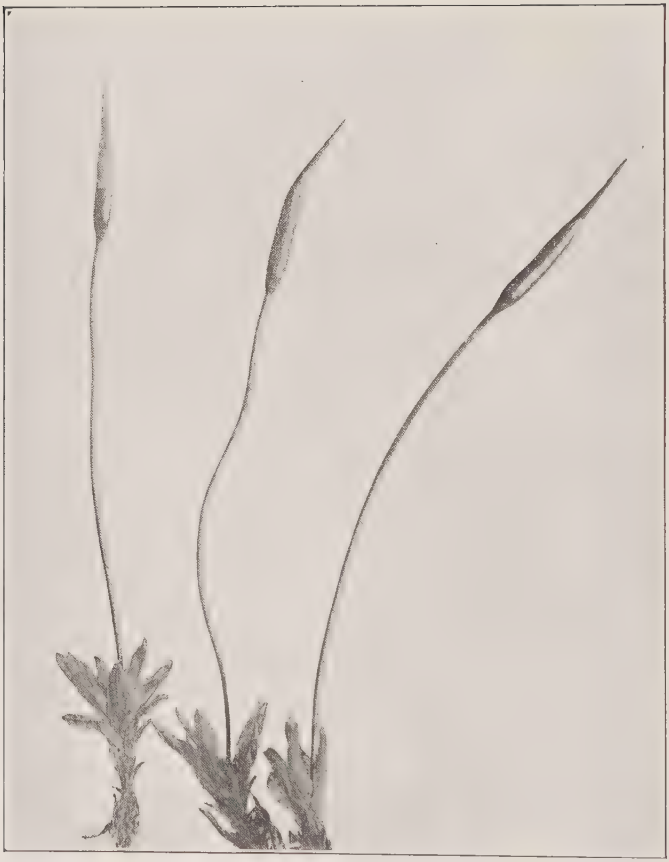


Plate XXXIV. *Tortula muralis*, × 9.

TÓRTULA. The Twisted Mosses.

The Twisted Mosses are large for the family and are easily recognized by the tongue-shaped leaves with long excurrent, hair-like costa, and by the long twisted peristome. To make out these characters satisfactorily it is best to mount the parts on a microscope slide. In all the species except *T. muralis* the basal part of the peristome is tubular.

The Twisted Mosses are not common, and the person who gets good fruiting material has cause for congratulation.

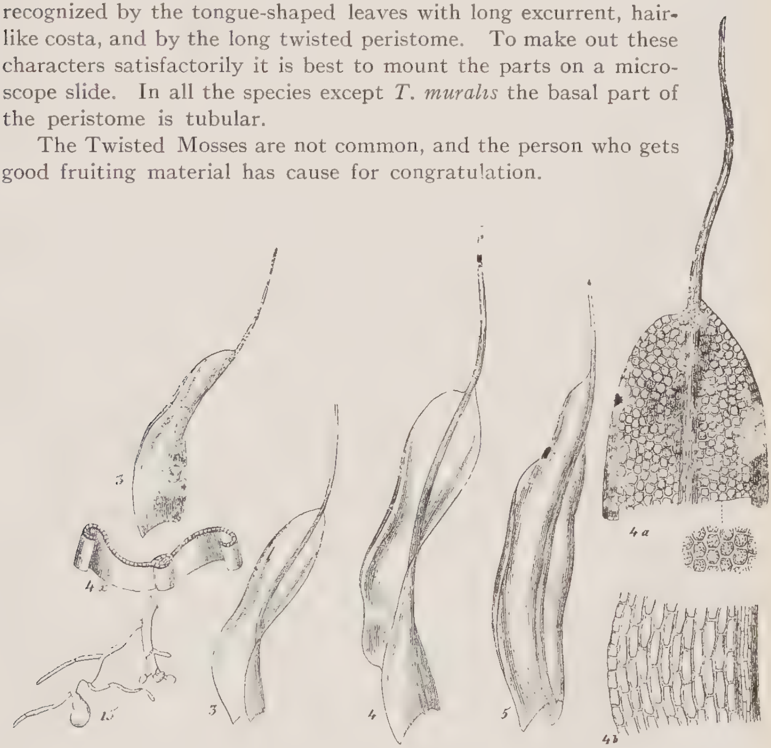


FIGURE 41.

Leaves, leaf sections, and radicles of *Tortula muralis* (From Bry. Eur.).

T. MURALIS (L.) Hedw. The botanical name of this plant is typical of the compactness and convenience of scientific terms. It means the Twisted Moss that grows on walls. And it is on walls and stones, especially those that contain lime, that one should look for this moss. It grows abundantly on the mortar of the wall at the upper side of the Richmond trolley line on Staten Island at the point opposite the New Dorp Railroad station.

It typically grows in small dense cushions, short, averaging about ½ inch high, dull or bright green; leaves twisted and curled when dry, oblong-lanceolate below to elongated-lingulate above; margin closely revolute, causing the leaves to appear margined; costa excurrent into a very long smooth hyaline hair which is usually one-half the length of the leaf; capsule broadly cylindric, on a red-brown seta which is orange when young. Distinct in fruiting forms by the narrow basal membrane. The combination of papillose leaf-cells, smooth hair-point and revolute margin will serve to distinguish from everything except possibly *Desmatodon plinthobius.*

T. RURALIS (L.) Ehrh. is larger than the preceding, 1 to 2½ inches high, branched, bright green above, reddish-brown below; leaves *recurved-squarrose above* when moist, when dry appressed and somewhat twisted, oblong to oblong-spatulate, *rounded or notched at apex;* perichaetial leaves acute; *costa excurrent into a very long and very rough hair which is hyaline above and often colored at base;* margin reflexed almost to apex. *The capsule is cylindric, long,* with lid half as long as capsule, basal membrane constituting one-half the long peristome; spores maturing in spring. On ground in woods and on stones. Common on the Pacific coast but infrequent eastward. Variable but distinguished by the italicized characters. The hair-point is so very strongly toothed that the roughness can be seen with a hand-lens. The western forms of this species grade into the form known as *T. ruraliformis* (Besch.) Dixon, a more robust plant with the leaves acuminate; the lamina at the base of the hair-point scarious and running up along the base of the hair.

DESMATODON PLINTHOBIUS Sulliv. & Lesq. is a small moss about ¼ inch in height, or less, which is common in the Central States. The leaves are smaller than those of *Tortula muralis* and the hair-point is often as long as the leaf, but otherwise so much like that species that confusion is likely to result. The small size of the plant and the short untwisted peristome will serve to identify it.

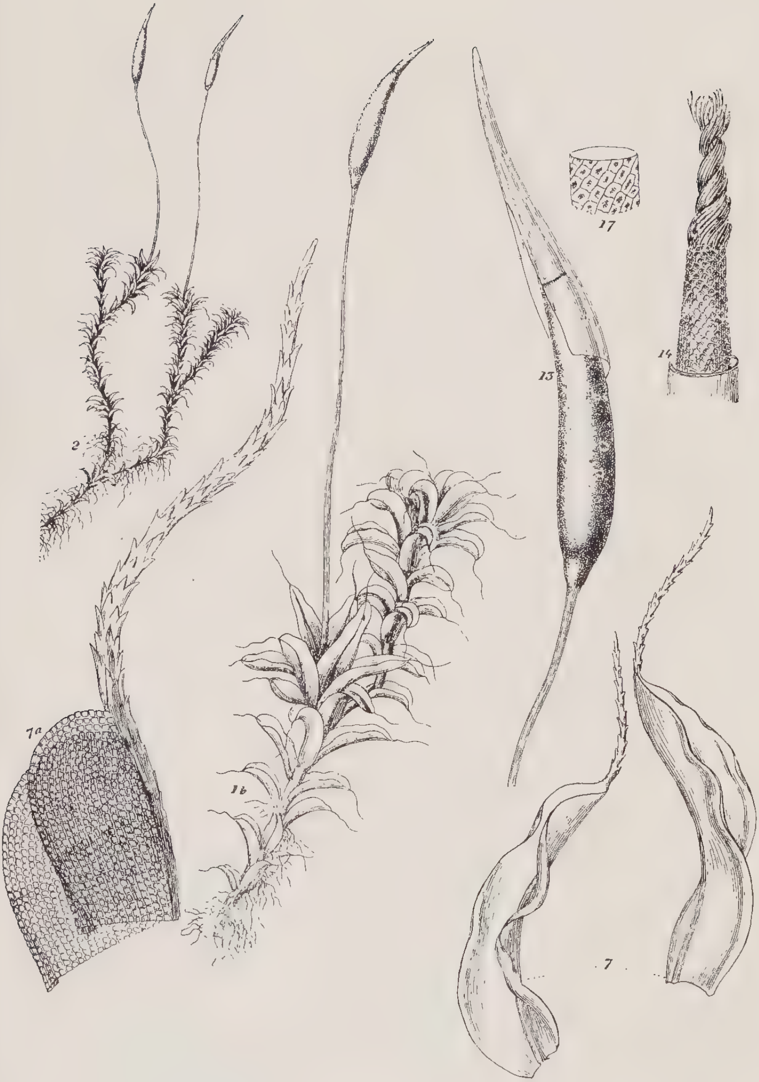

2
17
14
13
7a
1b
7

PLATE XXXV. *Tortula ruralis* (From Bry. Eur.).
2. Plant natural size. The other figures are self-explanatory.

FAMILY 10. ENCALYPTACEAE. Extinguisher Mosses.

We have but one genus of the Extinguisher Mosses, which as a whole are closely related to the Twisted Mosses in habit and leaf structure. The leaves are large and tongue-shaped and are crisped when dry as in Tortula, but the costa is little or not at all excurrent. When in perfect fruit there is no possibility of mistaking the Extinguisher Mosses, as the large extinguisher-like calyptra extends well below the capsule as shown in figure 42.

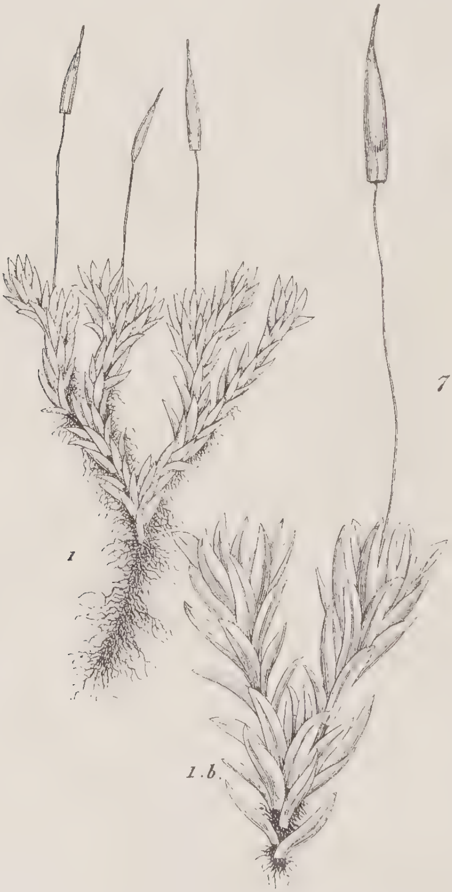


FIGURE 42. *Encalypta streptocarpa* (From Bry. Eur.). 1. Plant natural size. 1*b*. Plant enlarged.

ENCALÝPTA.

E. STREPTOCARPA Hedw., the Common Extinguisher Moss, is very common on limestone, but rarely or never fruits in this country. The plants are very large, 1 to 2½ inches in height, and many of the large (about ¼ inch in length) coarse leaves are strongly incurved at apex and sub-

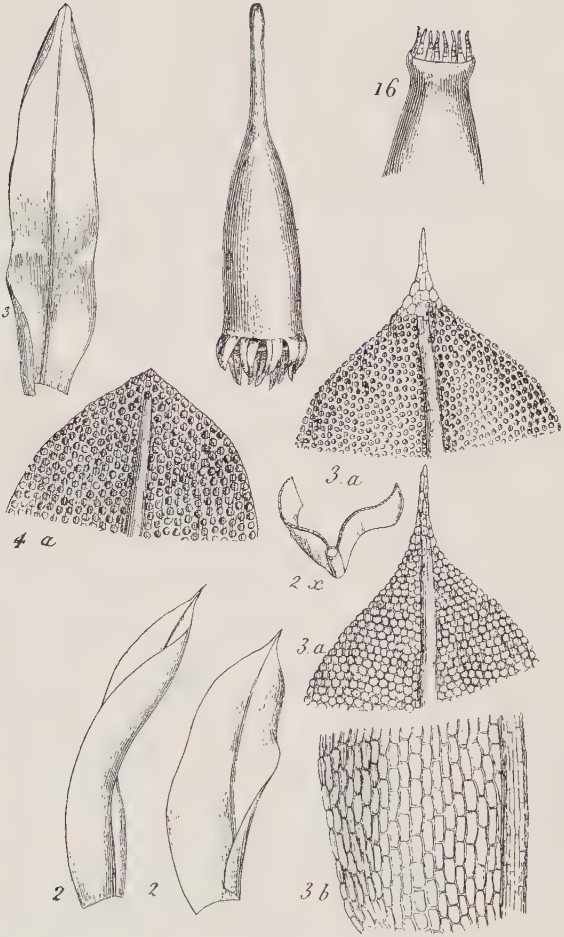


PLATE XXXVI (From Bry. Eur.).

3 and 4a. Leaf and flattened leaf-apex of *Encalypta streptocarpa.* The rest of the figures are of *E. ciliata.* 16. Mouth of capsule with peristome. At the left of 16 is the fringed calyptra. 2. Leaves. 3a. Apices of leaves. 3b. Cells at base of leaf. 2x. Cross-section of leaf.

cucullate. The costa does not reach the obtuse and rounded apex.

E. CILIATA (Hedw.) Hoffm., the Fringed Extinguisher Moss, is frequent on rocks in mountain regions. The plants are about one inch in height. The slightly excurrent costa, leaves plane-margined in the upper portion, and the fringed calyptra are its earmarks. The spores mature in summer.

FAMILY 11. ORTHOTRICHACEAE. The Orthotrichum Family.

Somewhat resembling the Grimmia Family, but nearly always growing on trees. The plants are small, rarely reaching an inch in height and usually much shorter, blackish or brownish green below. The leaves are oblong- or linear-lanceolate and usually very hygroscopic. The calyptra is nearly always hairy and the capsules often immersed, with very distinct longitudinal wrinkles when dry and empty. The peristome usually consists of 16 rather short teeth which are nearly always reflexed when dry and are often united in pairs; the inner peristome is usually represented by 16 slender hairlike processes, almost too minute for the hand-lens. In the *First Edition* this family was united with the *Grimmiaceae*. Members of these two families may become so dry and brittle as to crumble to dust in the fingers and yet retain their vitality unimpaired, springing into renewed growth with the next rain.

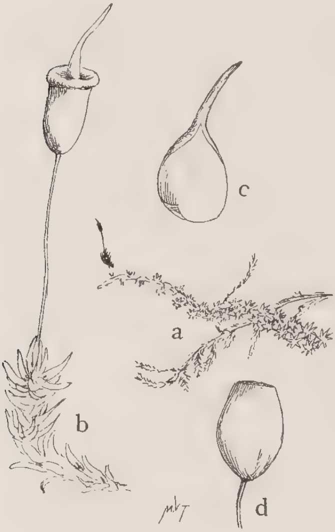


FIGURE 43. *Drummondia clavellata.* a, × 1. b, × 10. c, Calyptra, × 10. d, Empty capsule, × 10.

DRUMMONDIA.

Drummondia is a common moss of the Orthotrichum family. It always grows on the bark of trees, but is easily distinguished from its tree-growing allies by three characters. Its stems are long and closely applied to the bark of the tree, sending out short horizontal branchlets so thickly that the stems below become apparent only when the plant is removed. The capsule is on a long seta, the calyptra is cucullate, and the peristome is so small as to be scarcely apparent.

Drummondia is named for Drummond, one of the earliest collectors of American mosses. *D. clavellata* Hook. is our only species.

ULÒTA. (Weissia of the First Edition.)

The Ulotas have the characteristic brownish-green or blackish-green color of the Orthotrichum family. They are distinguished

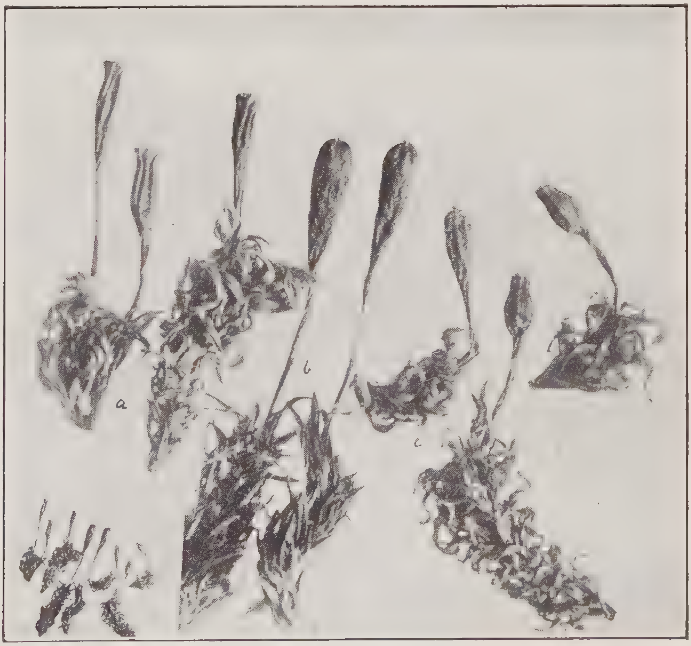


FIGURE 44.

Ulota, × 5. a, U. crispa. b. U. Ludwigii. c, U. crispa var. crispula.

from all save Orthotrichum by the hairy calyptra. Both Orthotrichum and Ulota grow on the bark of trees or more rarely on rocks, in cushions of varying size and thickness. The Ulotas growing on trees usually grow in more rounded tufts with the leaves more crisped when dry than is usual with Orthotrichum growing in similar

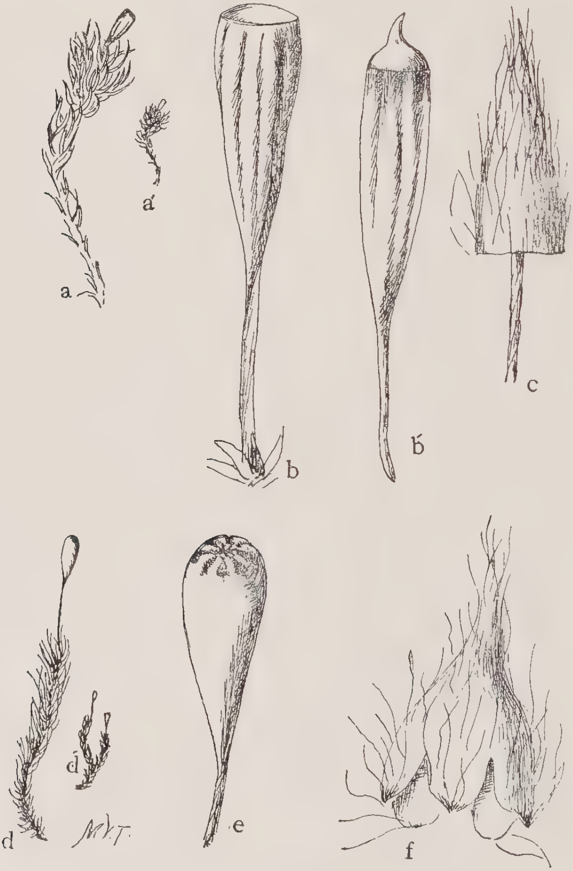


FIGURE 45.

a, a′, *Ulota crispa*, × 4 and × 1 respectively. b, b′, Capsules of the same, × 20. c, Young sporophyte with calyptra, × 20. d, d′, *U. Ludwigii*, × 4 and × 1, respectively. e, Capsule, × 20. f, Calyptra of mature capsule, × 21.

situations. The books all say that the hairs on the calyptra of Ulota are flexuous, and those on Orthotrichum straight, but this distinction appears to be rather too fine for the amateur to profit by it. The capsules in both genera are erect and symmetric and quite regularly striate when dry with eight or sixteen ridges and as many alternating furrows. These ridges consist of cells larger, darker, and thicker-walled than the alternating tissue. The seta in Orthotrichum is so short that the capsule is nearly always partially immersed; in Ulota the seta is long enough to exsert the capsule entirely beyond the perichaetial leaves.

U. LUDWIGII Brid., the Puckered Ulota, has pear-shaped capsules, abruptly narrowed to the very small mouth; the ridges and furrows extend only a short distance from the mouth of the capsule, giving it the peculiar and characteristic appearance shown in the cut.

U. CRISPA Brid. The capsules of the Crisped Ulota have a much larger mouth and are striate for the entire length. The seta is shorter, the color is lighter, and the tufts are rather thicker than in the Puckered Ulota. In the not uncommon variety *crispula* of the Crisped Ulota the capsule is much shorter and is suddenly contracted into a neck, narrow and much twisted when dry. These two species grow exclusively on trees.

U. AMERICANA (Beauv.) Lindb., the American Ulota, grows exclusively on rocks. Its leaves are rigid when dry like those of Orthotrichum, not crisped as in the two tree-growing species; the capsules very closely resemble those of the Crisped Ulota.

All three of the Ulotas are common in the hilly regions of our range. Their capsules mature in autumn or early winter, but apart from the calyptra are more characteristic when dry and empty. The tree-growing species furnish good collecting for winter and early spring, when most other mosses are buried under the snow.

The use of the name Ulota instead of Weissia seems to be sanctioned by the best authorities, hence the change.

ORTHÓTRICHUM.

The Orthotrichums are most frequent on trees about houses, and in orchards and village streets, although they are not lacking in other situations where the trees stand somewhat apart. They can be found abundantly on almost any fruit or shade tree in the country. In the larger cities for some reason they do not seem to thrive. They may frequently be found growing with Ulotas, from which the immersed or emergent capsule and non-crisped leaves distinguish them at once. One species (*O. anomalum*) grows on rocks. The calyptras are less densely hairy than those of Ulota; *O. strangulatum* has a calyptra without hairs. The species are usually considered difficult to identify even with a compound microscope, but I find that a few of the commoner species can be recognized with the aid of a hand-lens. Capsules must be thoroughly dry to answer the description of dry capsules. The leaves have revolute margins, except in *O. obtusifolium*, which appear as a darker margin when the leaves are mounted on a slide. Drummondia has the general appearance of an Orthotrichum with an exserted capsule, but the calyptra is cucullate and without hairs and the capsule is not wrinkled when dry.

The plate of *O. sordidum* gives a good idea of the characteristics of the genus.

KEY.

1.	Rock-inhabiting species; peristome teeth 16, erect or erect-spreading on dry capsules; capsule fully exserted, 16-striate	*anomalum.*
	Tree-inhabiting species; peristome teeth usually united into 8 pairs, recurved or reflexed when dry; capsule immersed or emergent, 8-striate	2.
2.	Leaves obtuse (rarely with some leaves acute), broad pointed, margins plane	*obtusifolium.*
	Leaves acute, margins revolute or involute	3.
3.	Capsule almost or quite exserted, smooth, or very slightly plicate around the mouth when dry and empty	*speciosum.*
	Capsules immersed or slightly emergent, plicate the whole length when dry	4.
4.	Empty capsule strongly contracted below the mouth when dry and empty, dark colored	5.
	Empty capsule only slightly contracted below the mouth, straw-colored	*ohioense.*
5.	Empty capsules dark red-brown on the folds, so deeply folded in many cases that the folds almost touch each other; calyptra without hairs	*strangulatum.*
	Plants larger with hairy calyptras; capsules lighter colored and less deeply plicate	*sordidum.*

O. ANOMALUM Hedw. Rock O. (Figure 46) grows on rocks in rather dense cushions, dark olive green or brown below; calyptra hairy; capsule usually fully exserted, 16-striate, the 8 intermediate folds less distinct, oval-cylindric when moist, cylindric when dry, abruptly narrowed to the neck. The peristome is erect when dry, of *16 teeth*, usually separate. Spores maturing May-June. Not rare.

This species will not be confused with any other species of *Orthotrichum*, but may be confused with *Ulota americana*. The latter has the dry capsule gradually narrowed into the long neck and the teeth *reflexed* when dry; besides it is almost black in color except at the extreme ends of the stems and branches, and grows in loose wide mats. Its spores mature much later, July-September.

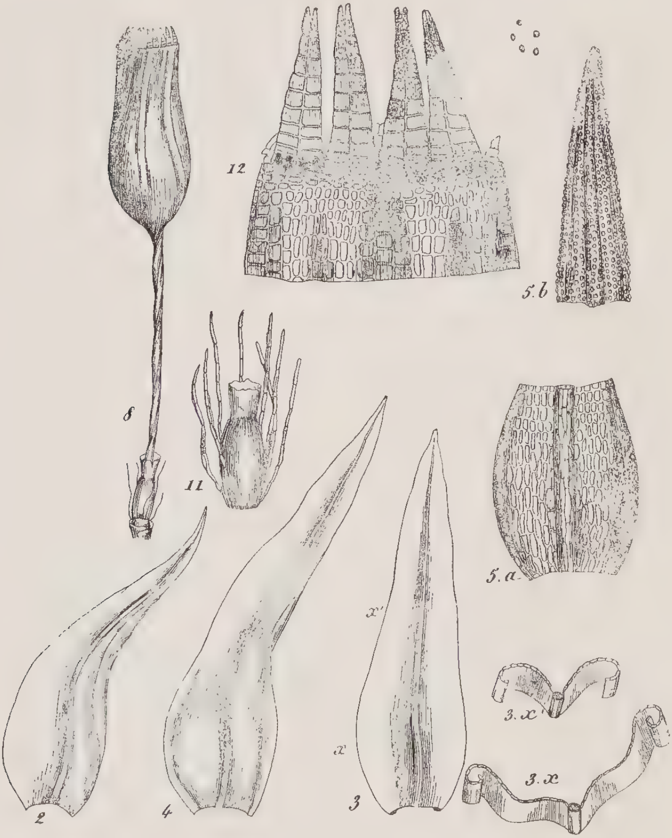


FIGURE 46. *Orthotrichum anomalum* (From Bry. Eur.).

2, 3, 4 and 5. Leaves; x and x′ indicate where the sections 3x and 3x′ were made. 11. Vaginula.

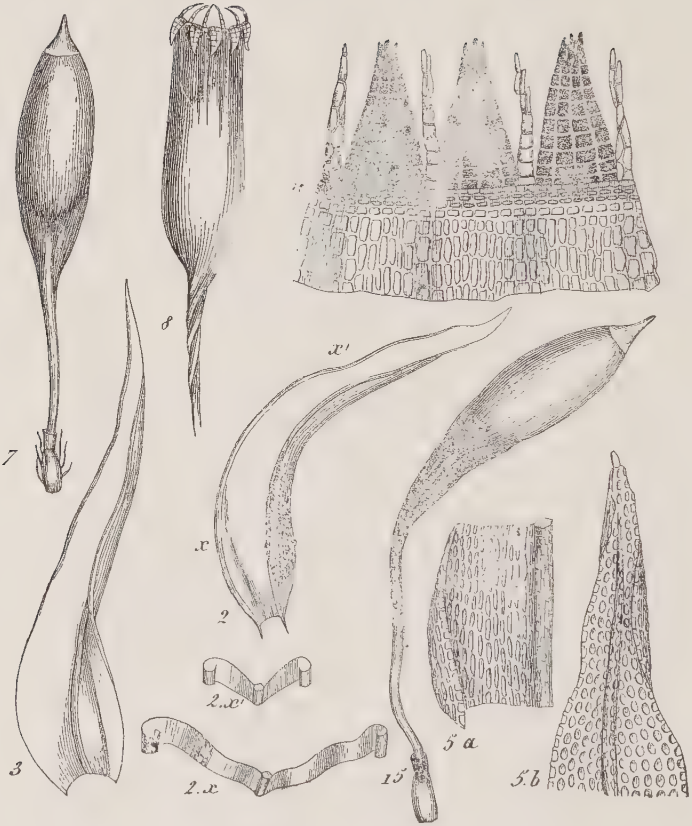

7
8
x'
x
2
3
2.x'
2.x
15
5 a
5.b

Plate XXXVII. *O. speciosum* (From Bry. Eur.).
2, 3 and 5. Leaves. 7, 8, 10 and 15. Capsules and peristome.

O. OHIOENSE S. & L. (Figure 47) grows in rather dense, small cushions, yellowish green, brown below; stems about 1-inch long; leaves oblong-lanceolate; calyptra hairy, moist capsule immersed, oblong-ovate, when dry slightly 8-plicate, campanulate, becoming more narrowed with age, *straw-colored;* peristome of 8 double teeth, strongly reflexed when dry. The spores mature in early spring (April). Common on trees. When sterile it is a difficult matter to distinguish this from *O. strangulatum*, but the straw-colored lightly plicate capsules are easy of recognition.

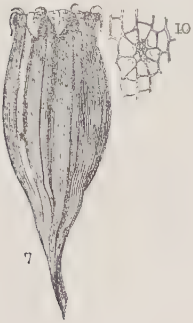


FIGURE 47. *Orthotrichum ohioense.* Dry and empty capsule. 10. Stoma.

O. SPECIOSUM Nees, the Smooth Orthotrichum, is perhaps the largest of our species, being an inch to an inch and a half in height, yellow-green above; leaves tapering, very acute. The calyptra is large, hairy, campanulate; capsule oblong-cylindrical, almost exserted, the upper leaves barely reaching the base, *smooth or barely marked with irregular ridges when dry;* operculum rostellate; peristome of 8 teeth, which when dry are recurved rather than reflexed, as the tip of the tooth sometimes touches the capsule wall in a way to remind one of the handle of a mug. The spores mature by October, but I have collected operculate capsules in March.

O. SORDIDUM S. & L. somewhat resembles the preceding in leaf characters. It is at once distinguished by the immersed or emergent plicate capsules. The spores mature in late spring or summer. (Pl. XXXVIII.)

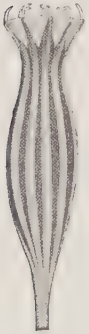


FIGURE 48. Capsule of *Orthotrichum strangulatum.*

O. STRANGULATUM Sulliv. (Pl. XXXIX.) This is one of our commonest mosses, abundant on shade trees almost everywhere. It can be recognized with a hand-lens by the characters given in the key if one is familiar with it. The capsules are not so deeply plicate until a month or more after the spores ripen. It is a little smaller than the preceding, the leaves are narrower, and the calyptra naked; the spores apparently mature about a month later.

In August I have found *O. speciosum*, *O. sordidum*, *O. strangulatum*, and *O. Ohioense*

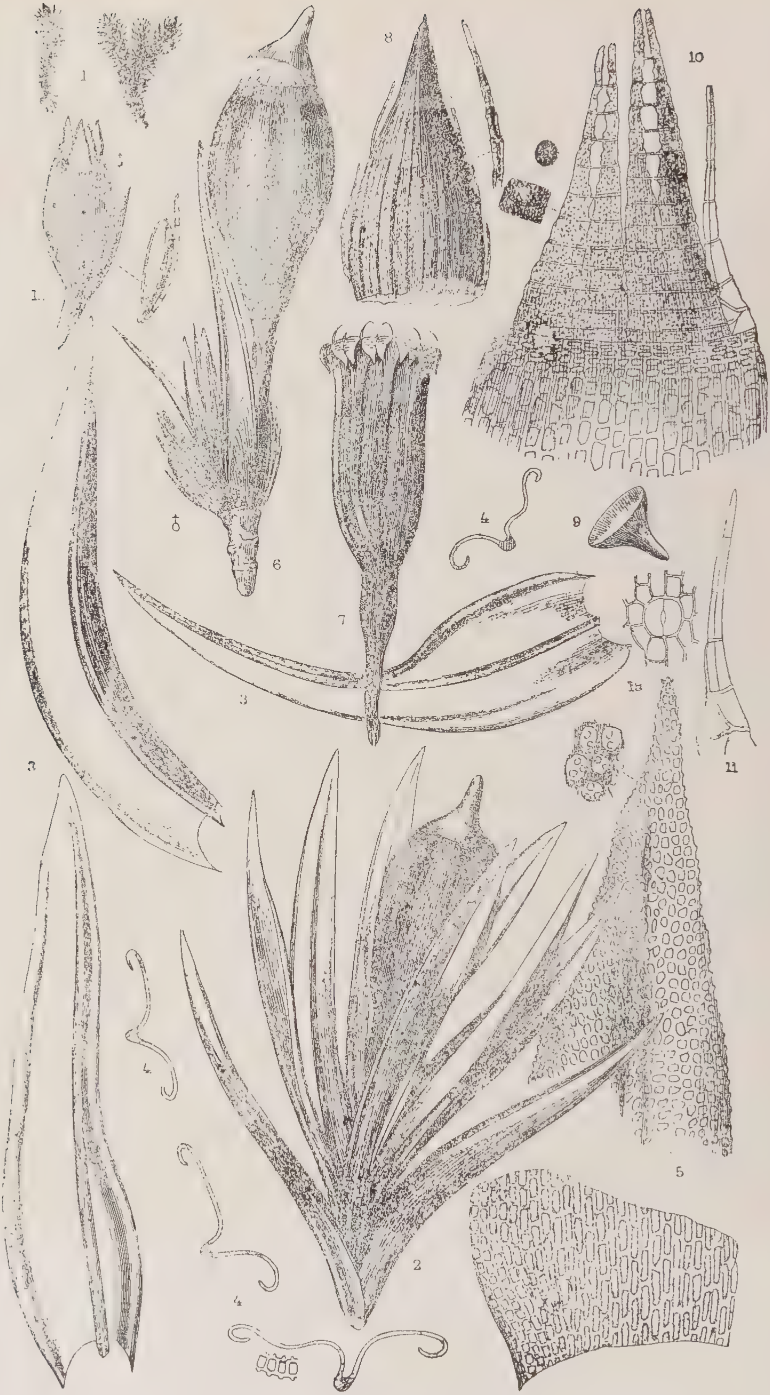

1
8
10
1
♂
6
4
9
7
3
13
11
3
4
5
2
4

Plate XXXVIII. *O. sordidum* (From Sulliv. "Icones Musc. Suppl.").
1. Plants natural size. 13. Superficial stoma.

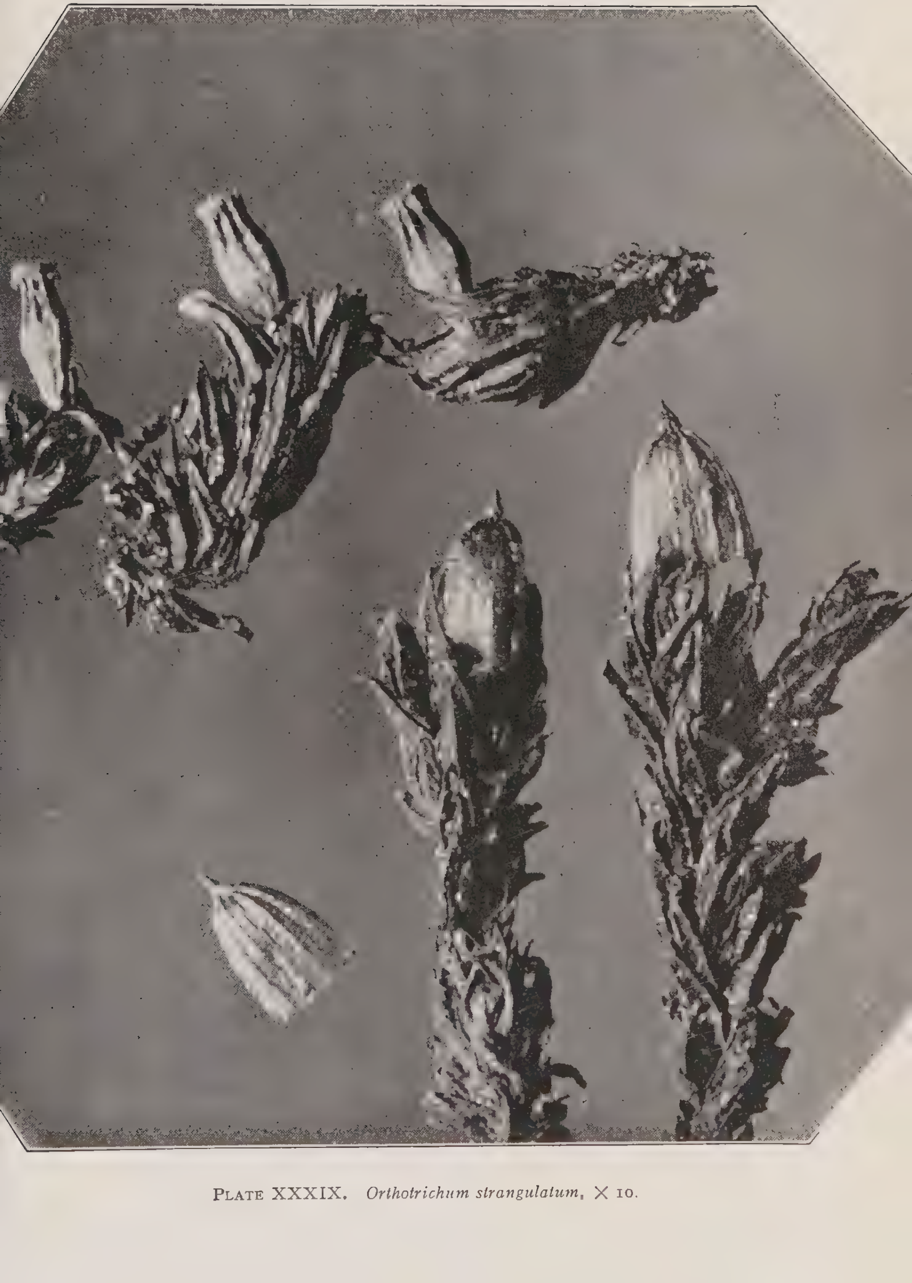


PLATE XXXIX. *Orthotrichum strangulatum*, × 10.

growing together on fruit trees. *O. strangulatum* is much the most abundant, and is easily recognized by the strangulate, dark red-brown capsules appearing as described in the text. *O. Ohioense* is about the same size, but the straw-colored capsules catch the eye at once. *O. sordidum* stands out at once by reason of its greater size and larger leaves and capsules less plicate than in *O. strangulatum*. *O. speciosum* is somewhat smaller than *sordidum*, and at this time the capsules are immature with the hairy calyptra still firmly attached. The comparative size of *speciosum* and *sordidum* is just the reverse of what my herbarium specimens and the book descriptions lead me to expect as the specimens of *speciosum* I collected were much smaller than those in my herbarium.

FAMILY 12. SCHISTOSTEGACEAE. The Luminous Moss Family.

SCHISTÓSTEGA OSMUNDACEA (Dicks.) Mohr., the Luminous Moss, belongs in a family all by itself because of its numerous peculiarities. It is found in caves and dark holes in the woods, sometimes under the roots of over-turned trees. It has once been found under the sill of an old shed.

On looking into one of these caverns containing the Luminous Moss, the bottom seems covered with a golden-green glow, something like the appearance of a cat's eyes in the dark. In order to see the glow one must look into the cave with the light behind him and care must be taken not to shut off all the entering light, as the Luminous Moss, like the moon, shines by reflected light alone. If one attempts to gather the glowing substance he will find nothing but dirt and stones with possibly a few tiny green plants like those in the figure. The compound microscope will reveal threads like those shown in the plate, but the lens will show only a cobwebby appearance of fine green threads. This beautiful plant is probably the reality upon which are based the fairy tales of goblin gold. The discovery of this rare and curious plant will repay a search in every dark hole one sees. If present it can always be seen from the outside, as it cannot grow beyond the reach of light. Mrs. Britton's Observer articles give a much fuller account of this moss.

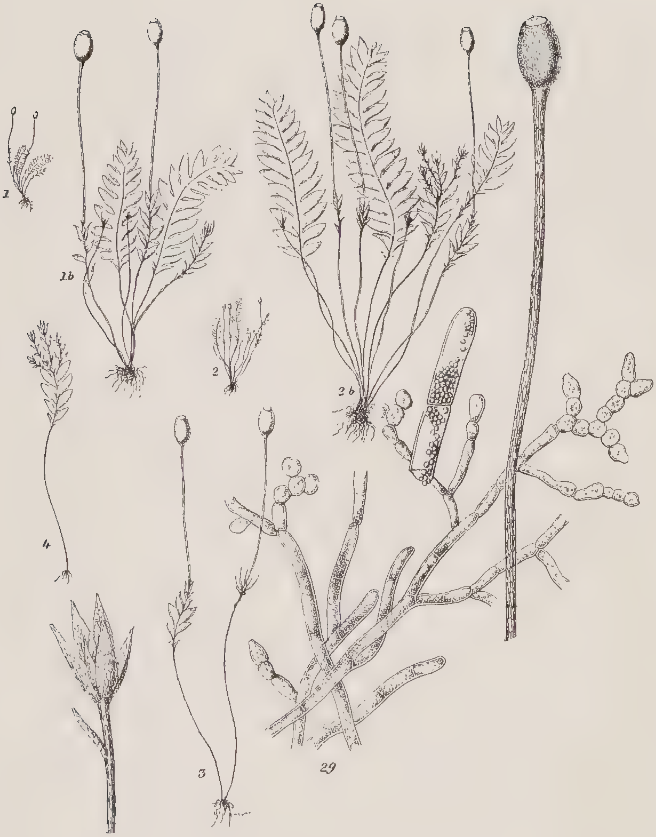


PLATE XL. *Schistosega osmundacea* (From Bry. Eur.).

1, 2. Plants natural size. 29. Protonema as it appears under the compound microscope.

FAMILY 13. SPLACHNACEAE. The Splachnum Family.

SPLÁCHNUM.

There are several species of Splachnum, but only one is likely to be found.

S. AMPULLACEUM L., the odd looking moss represented in Fig. 49, is not very common and will not be found readily by most students. It is so striking in appearance that no one can fail to recognize it. The spores are borne in the slender upper portion; the swollen and colored (lilac or purplish) lower portion is the neck of the capsule, which is covered with stomata and filled with loose tissue suitable for the assimilation of carbon dioxide. When dry this portion becomes irregularly shrunken in a manner very difficult to represent in a drawing.

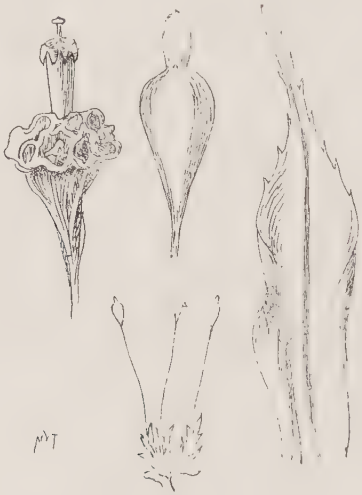


FIGURE 49.

Splachnum ampullaceum; leaf, × 10; capsule, ripe and unripe, × 5. (The plant and capsules represented are rather small, as they are often found of twice this size.)

There are several other rare mosses of the Splachnum Family, all remarkable for the swollen neck (much less conspicuous than in Splachnum, however), and for growing on animal excreta or decaying animal tissue.

FAMILY 14. FUNARIACEAE. The Cord Moss Family.

FUNÀRIA Schreb.

Funaria hygrometrica (L.), Sibth., the Cord Moss, is so called because of the twisted seta, which is very hygroscopic and untwists when moist. Its Latin name, Funaria, is derived from *funis*, a rope. This twisting of the seta is not peculiar to this moss, however, but is a very common thing in nearly all moss families.

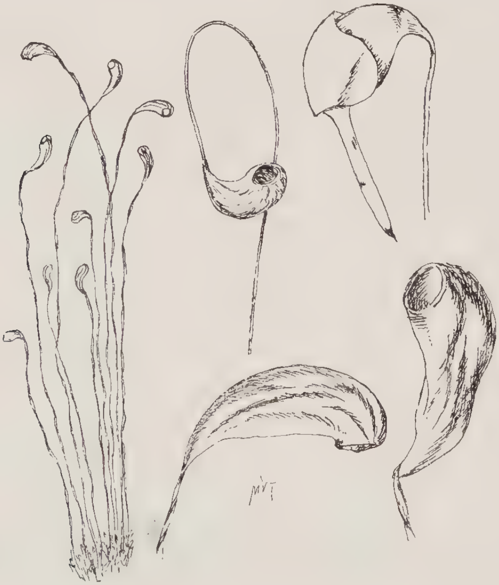


Figure 50.

Funaria hygrometrica, × 2, with capsules of various ages and degrees of magnification.

The Cord Moss is to be found everywhere, being especially abundant in waste places and on soil recently burned over. I have seen it completely cover the soil in an old strawberry bed. When mature it is easily recognized by the peculiar looking curved capsule with its mouth on one side. When immature it is much harder to

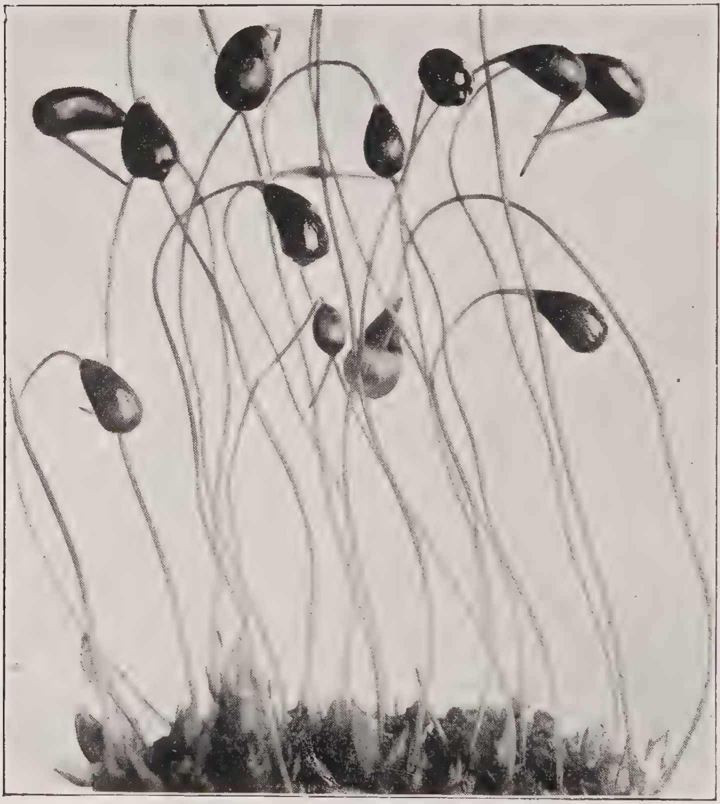


Plate XLI. *Funaria hygrometrica*, × 4.

recognize, because the capsule is erect and nearly symmetric and the calyptra has not assumed the rakish position indicated in the figures.

This moss has perhaps been given a more careful study than any other species; it is described in nearly every text book on botany. There are several other species in the United States, but this is the only one commonly found. The capsules mature early in June.

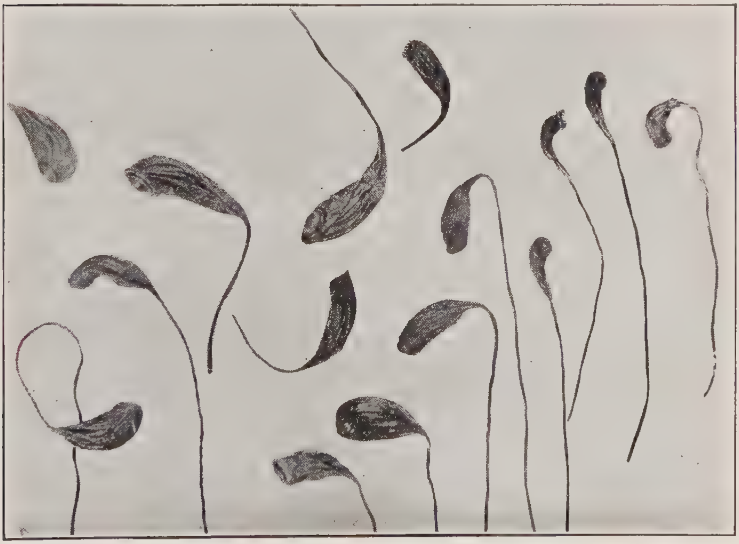


FIGURE 51.

The 4 capsules on the right are *Funaria americana*. The 5 to the left of these in an irregular line are *F. flavicans*. The others *F. hygrometrica*. All, × 5.

F. FLAVICANS Mx. is found from New York southwards. We are indebted to Mr. R. S. Williams for the following notes which are taken from the "Bryologist" of January, 1901: "The species grows in separate tufts as well as mingled with *hygrometrica*, from which it may be distinguished by the average smaller size, erect pedicel, more pointed leaves, and mouth less oblique, as well as less furrowed capsule, which matures a week or two earlier than in *hygrometrica*, in this region at least, where the best specimens were collected from the 1st to the 10th of June. When well ripened, the capsules are very dark reddish, with a low convex lid, not apiculate." Mr. Williams also states that the mouth of the capsule is constantly smaller in *flavicans*.

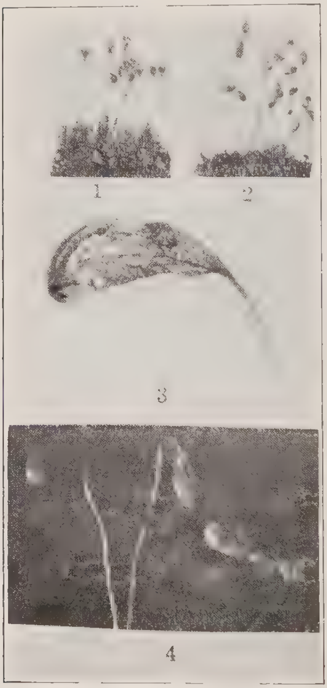


FIGURE 52.

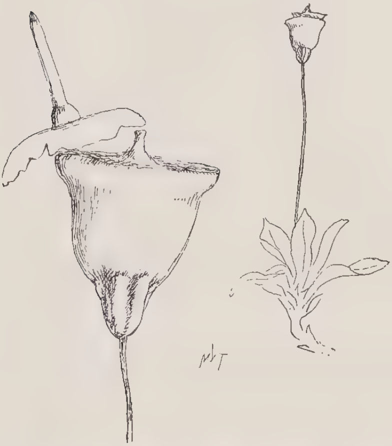
1. *Physcomitrium turbinatum*, × 1. 2. Small *Funaria hygrometrica*, × 1. 3. Capsule of *F. hygrometrica*, × 7. 4. Capsules of *F. flavicans*, × 3.

PHYSCOMÍTRIUM.
The Urn Mosses.

P. TURBINATUM (Mx.) Brid., the Common Urn Moss, is common on earth in conservatories, by roadsides and in old fields. It is abundant in moist places by paths in the parks of Greater New York. It must be collected in May to get the calyptra in position. Although a very near relative of the Cord Moss, it entirely lacks the peristome which is so conspicuous in that species.

A much rarer moss, Pottia, may be found and confused with the Urn Moss, which it closely resembles. Pottia, however, is smaller, being about one-half as large, matures its capsules in winter, and under a lens will be seen to have the midrib excurrent instead of ending below the apex of the leaf, as in the Urn Moss.

There are several species of Urn Mosses, but this is much the most common and most likely to be met with.



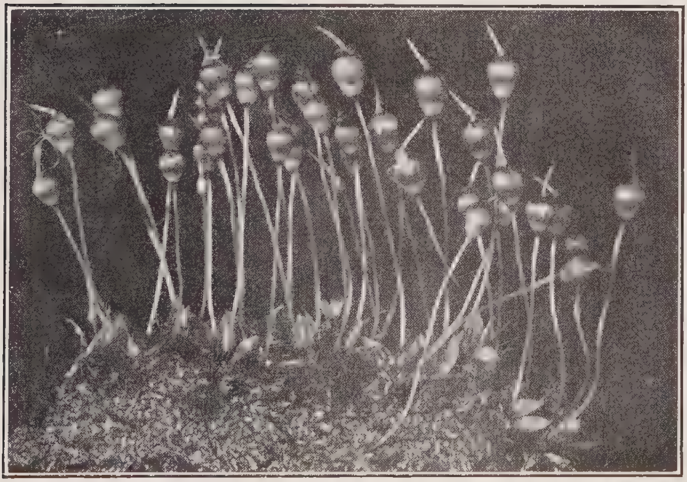


PLATE XLII.

FIGURE 1.

Physcomitrium turbinatum, × 4; capsule, × 15.

FIGURE 2.

Physcomitrium turbinatum, × 4.

PÓTTIA.

Pottia belongs in the Tortula Family, but is treated here because of its resemblance to Physcomitrium. Plants short, branched, scattered or in tufts. Leaves soft, broad in outline, enlarging upwards, ovate to oblong, *costa reaching apex or beyond.* Capsule erect and exserted on a straight seta, ovoid to cylindric; peristome lacking in our species.

P. TRUNCATULA (L.) Lindb. (P. *truncata* Fuern.) is our only common species, and will be readily recognized from the generic description and the figure. It is most likely to be confused with

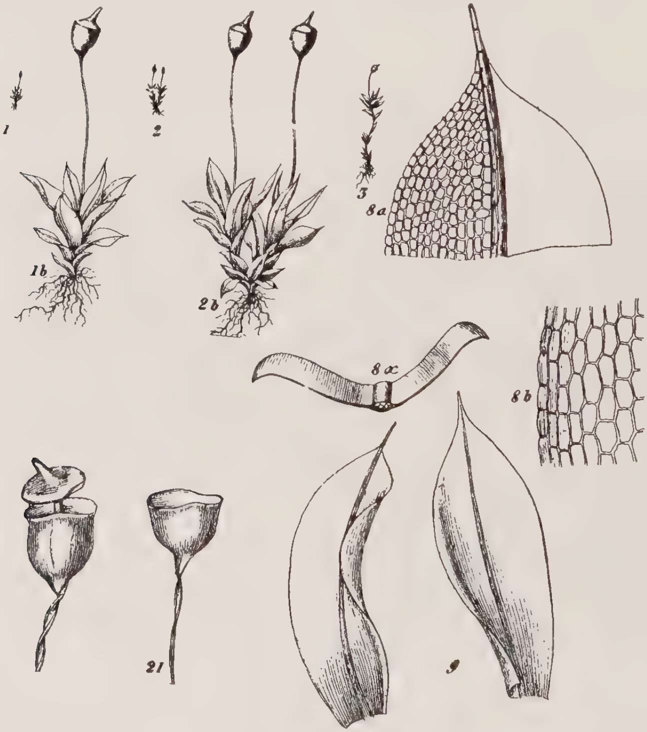


FIGURE 53. *Pottia truncatula* (From Bry. Eur.).
1, 2, and 3. Plants natural size. 8b. Leaf cells.

FAMILY 15. AULACOMNIACEAE. Bog Moss Family.

Closely related to the Mniums, but distinguished in our species by the capsules, which are strongly and regularly wrinkled when dry.

Gymnocybe has been dropped for *Aulacomnium* because the latter seems to be in most general use.

AULACÓMNIUM. The Bog Mosses.

A. PALUSTRE Schwaegr., the Ribbed Bog Moss, is very abundant in swamps and wet shaded hollows. It is rather lighter in color than most of the accompanying mosses. When in fruit it is readily distinguished by its capsules, deeply furrowed when dry. From Physcomitrium, as its habitat and general appearance are somewhat similar. The spores mature from late autumn to early spring.

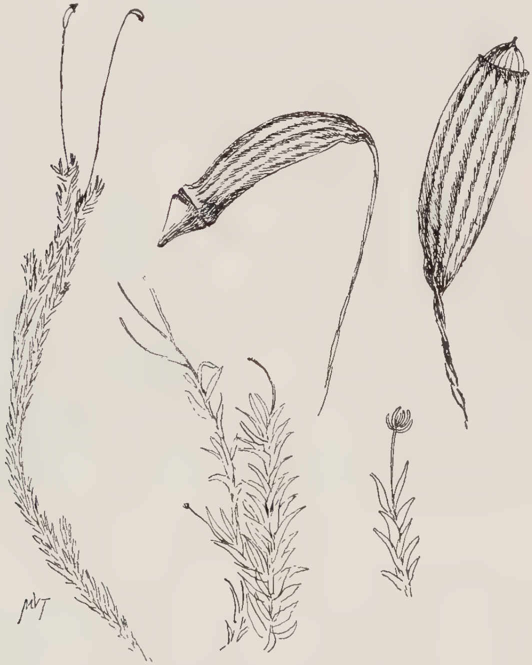


FIGURE 54.

Aulacomnium palustre, capsules, × 7.

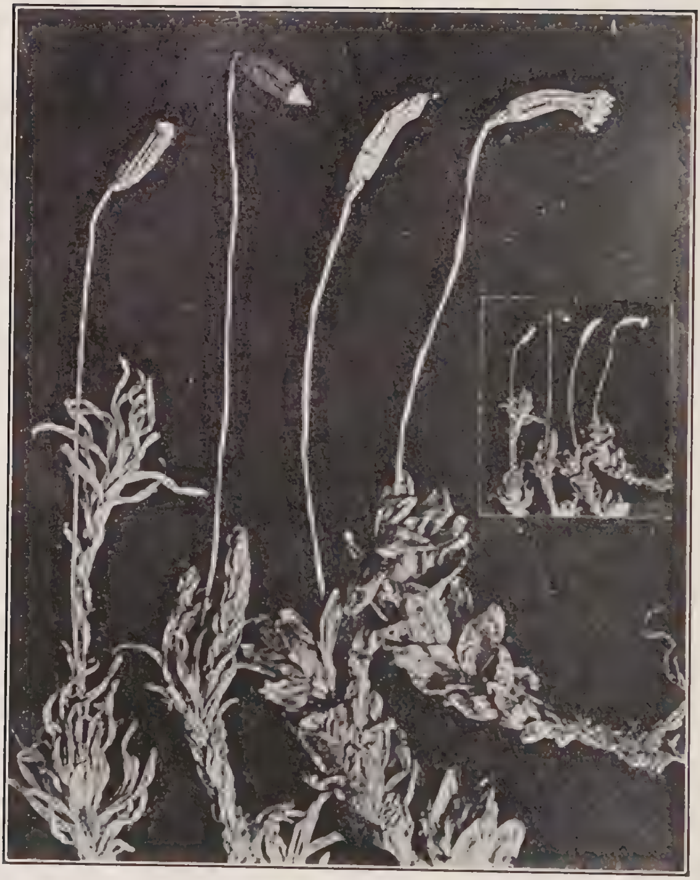


PLATE XLIII.

A. Aulacomnium palustre (left) and *A. heterostichum* (right). × 5.

the figures the capsules might possibly be confused with those of Ceratodon, but they are much longer and much lighter colored (yellow-brown). The plants are several times as large as those of Ceratodon, often reaching a height of two or three inches. Note also the difference in habitat.

When not in fruit, this species frequently bears on the end of the stem a number of long slender leafless stalks, which, when young, bear clusters of gemmae at their ends. These gemmae serve to reproduce the plant asexually and may account for the rather infrequent appearance of the sporophyte.

The capsules mature in early summer.

A. HETEROSTICHUM (Hedw.) B. & S. looks so much like a Mnium that it might well be called the Ribbed Mnium. It is common on rich moist soil (not wet) in woods, especially about the bases of trees. The ribbed, or wrinkled, capsules and broad Mnium-like leaves, coarsely serrate and without border, are its distinguishing marks. The spores mature in early spring, but the young "lances" are well started in the preceding autumn. When thoroughly dry the capsules are more strongly wrinkled and more contracted under the mouth than is shown in the plate.

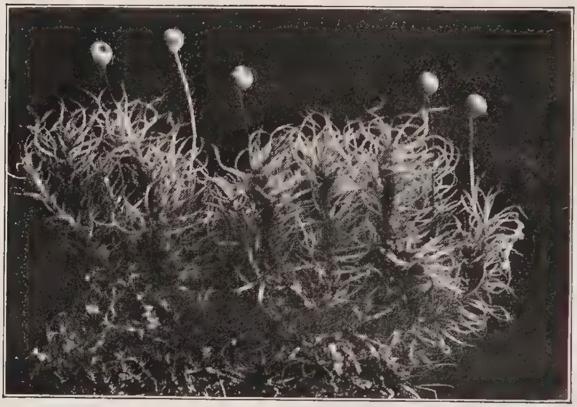
FAMILY 16. BARTRAMIACEAE. Apple Moss Family.

The plants of this family mostly grow on rocks that are moist or in many cases, very wet. The capsules are subspherical when moist, but are strongly wrinkled when dry.

BARTRÁMIA.

The Bartramias grow in moist niches in cliffs and on moist shady banks, looking much like tufts of green wool. The characteristic thing about them is their capsules, which are globular and somewhat unsymmetric when moist, but dry with regular folds and alternate ridges. When very dry the body of the capsule becomes so shrunken as to be smaller than the mouth of the capsule itself. We have two species.

B. POMIFORMIS (L.) Hedw., the Long-leaved Bartramia or Apple Moss, easily distinguished by its longer leaves crisped when dry and by its larger capsule.



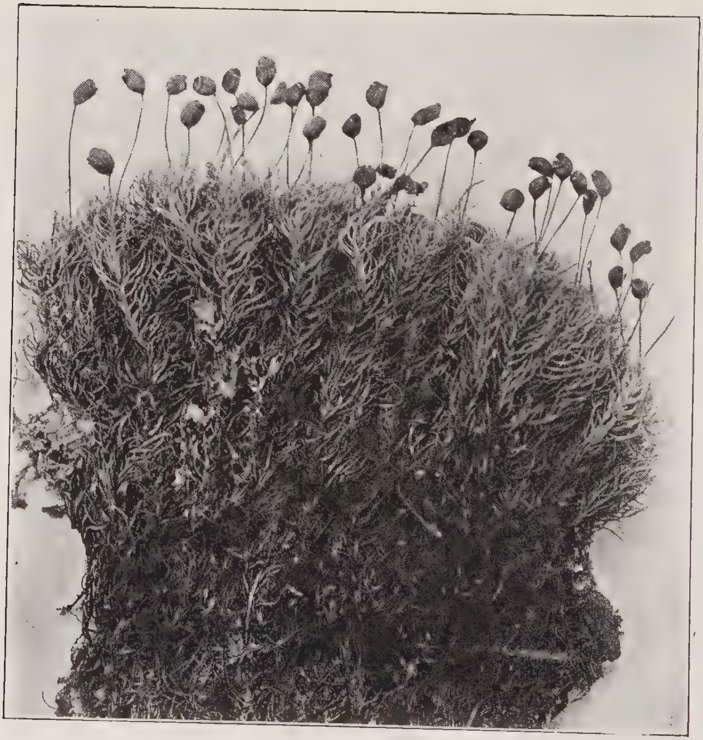


PLATE XLIV. *Bartramia pomiformis.*

Above moist, × 3. Below dry, × 4.

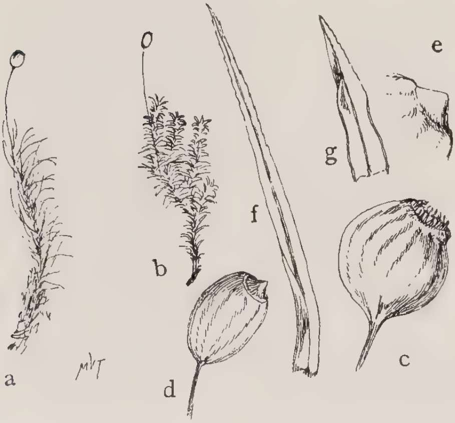


FIGURE 55.

a. *Bartramia pomiformis*, × 1. b. *B. Oederi*, × 1. c. Capsule of *B. pomiformis*, × 10, and e, Mouth of same with operculum. d. Capsule of *B. Oederi*, × 10. f and g, Leaves of *B. pomiformis* and *B. Oederi* respectively, × 10.

B. OEDERI (Gunn.) Swartz., the Short-leaved Bartramia. The Long-leaved Bartramia is common throughout our range whenever the country affords a suitable habitat, but the Short-leaved Bartramia is rather rare. The difference between the species as shown in the figures is so marked that they cannot be confused.

Both species mature their capsules in spring; the Long-leaved Bartramia in April or early May, and the Short-leaved two or three weeks later.

PHILÓNOTIS.

P. FONTANA (L.) Brid. is the only species of Philonotis likely to be met with, is very common where water drips or runs in shallow streams over rocks. When in fruit it may be mistaken for a Bartramia on account of the similarity of the capsules. The capsules of Philonotis, however, have a protuberance on the lower side that is entirely lacking in Bartramia.

Philonotis grows in much wetter places, has much longer, more slender stems that are often fasciculately branching at the top; shorter, more acute leaves, and is dioicous. The male heads are conspicuous objects among the fruiting plants, though seldom

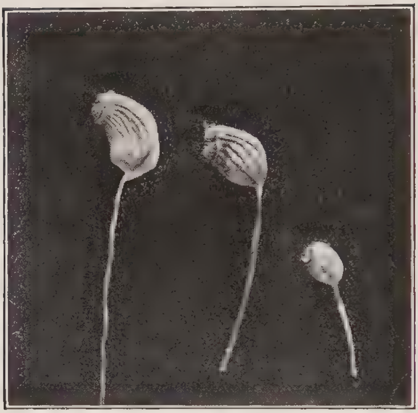


FIGURE 56.
Capsules (left to right) of *Philonotis fontana*, *Bartramia pomiformis* and *B. Oederi*, × 5.

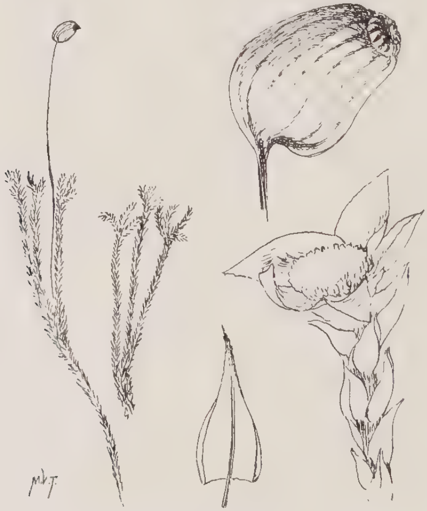


FIGURE 57.
Philonotis fontana, × 1; leaf, capsule, and male head, × 10.

appearing in sterile mats. Although Philonotis is common, the sporophyte is infrequent. The capsules mature in May or June.

FAMILY 17. BRYACEAE. The Bryum Family.

The capsules of the Bryum Family are nearly always drooping and frequently have a well-marked neck when dry. The peristome is double and well developed. (See glossary under "Peristome".) The leaves are usually plainly bordered by a thicker darker margin of elongated cells, and the costa is stout and often excurrent.

BRỲUM.

Bryum is perhaps the most difficult and troublesome of all the genera of mosses. The genus is large (500 species, 195 in Europe and America), and the distinctions between the species are often few and difficult to observe. There are, however, several species that can be recognized readily.

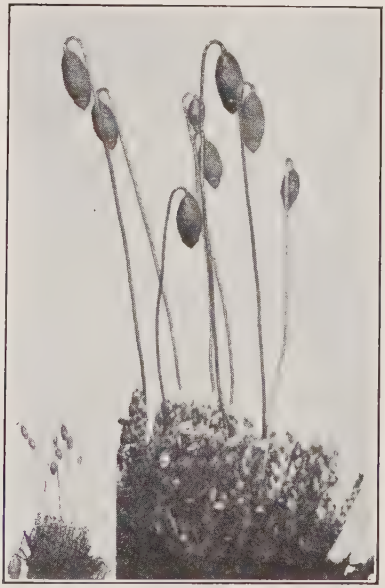


FIGURE 58.
Bryum argenteum, × 1 and × 4.

It is hard to distinguish in a description between Mnium and Bryum, but after one has collected them much he will rarely make a mistake. In general the leaves in Bryum are smaller, and the leaf cells are longer and proportionately narrower. The Giant Bryum, however, is very like a Mnium in size and shape of leaf.

Many species other than those mentioned here are sure to be found, but the genus is one of the most difficult, and cannot be thoroughly studied with the hand-lens alone. Pohlia (Webera of many authors) is treated with Bryum because of its close resemblance. It is by many authors included in Bryum. The leaf cells in Pohlia are much longer and narrower than in Bryum, but it is difficult to see this satisfactorily with a lens.

B. ARGENTEUM L., the Silvery Bryum, grows everywhere at almost all altitudes. It is specially fond of dry compact soil in sandy fields and waste places. It grows abundantly in paths and between the bricks of sidewalks in towns and cities.

When fully grown it is a bright silvery gray, due to the fact that the leaves are white and without chlorophyll when old. The young plants are green and may easily be mistaken for something else. The leaves end in a slender bristle and are crowded and closely overlapping, making the stems and branches prettily julaceous.

The capsules mature in autumn, but can be found in recognizable condition at almost any season. When fully mature the seta and capsules are dark red.

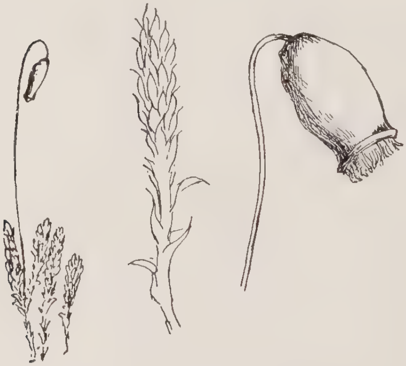


FIGURE 59.
Bryum argenteum, × 4; branch, × 10; capsule, × 20.

B. ROSEUM (Weis) Schreb., the Giant Bryum, is the largest and showiest of all our species, and, moist and fully expanded, is a striking object in any situation. The stems spring from stolons and are nearly leafless except at the summit, where the very large leaves form a rosette. Under favorable circumstances it forms large mats on old rotten logs or at the base of trees

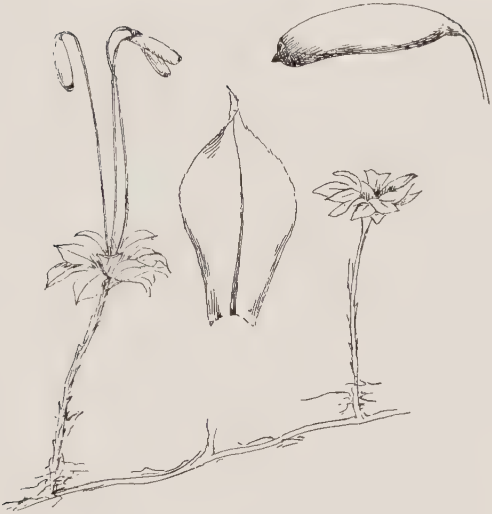


FIGURE 60.
Bryum roseum, × 1; leaf and capsule, × 4.

in rich peaty soil. Although common, it seldom fruits in either America or England, but reproduces freely by its stolons.

The antheridia mature in late August or early September, and the male heads are so large and conspicuous that it is easy to find them in almost any locality where the species grows. The antheridia are so large as to be easily seen with a hand-lens. One who has access to a compound microscope should not fail to study the antherozoids with high powers.

B. CAESPITICIUM L., the Common or Matted Bryum. There is no particular reason for calling this species "matted" except to translate its scientific name, but it is by all odds the most common species. It grows among thin grass in open fields, around the edges of ledges and bare spots of soil, and on old ash heaps; usually in dry places. It is often associated with Funaria. There are two or three species so closely related to it that it is almost impossible to distinguish them with a lens, but this is so much more common than any of the others that in nine cases out of ten anything answering to the following description and figures will be the Common

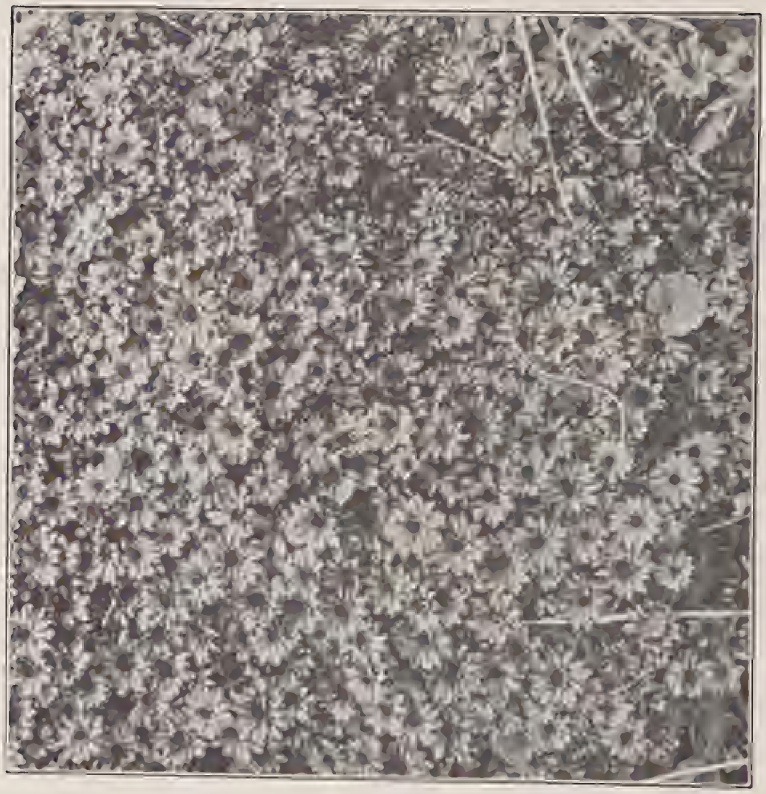


PLATE XLV.

Mat of *Bryum roseum* somewhat reduced. Photo by D. Lewis Dutton.

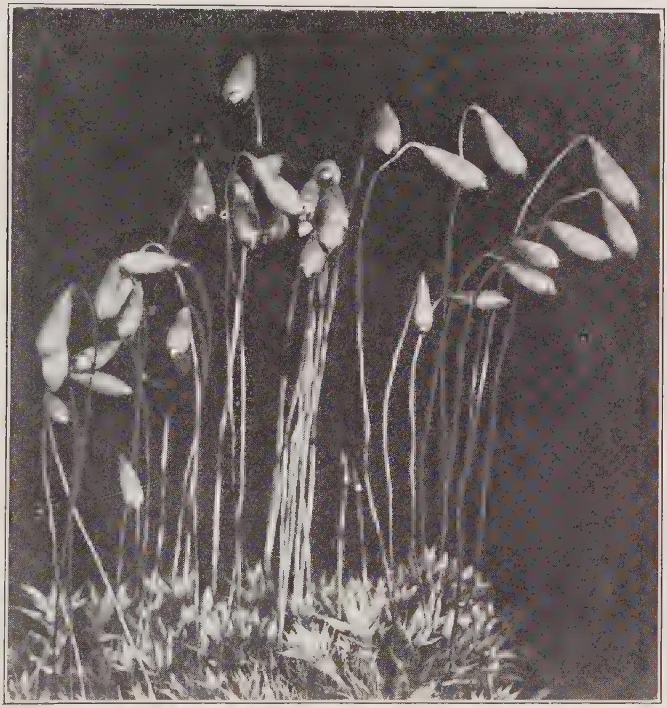


FIGURE 61.
Bryum caespiticium, × 2.

Bryum. The size and general appearance of the plants are well represented in the cuts. The leaves are plainly bordered; the costa is excurrent; the antheridia grow intermingled with the archegonia (difficult for the lens). The capsules mature in May and June, and as the antheridia and archegonia are ripe at about this time, it must take the plant a full year to mature its spores; for this reason the leaves at the base of the seta are often badly torn and decayed.

B. BIMUM Schreb., the Red-stemmed Bryum, is another common species, growing on wet cliffs and in swamps. It is known by its large size (2–6 inches) and the dense felt of red-brown radicles that

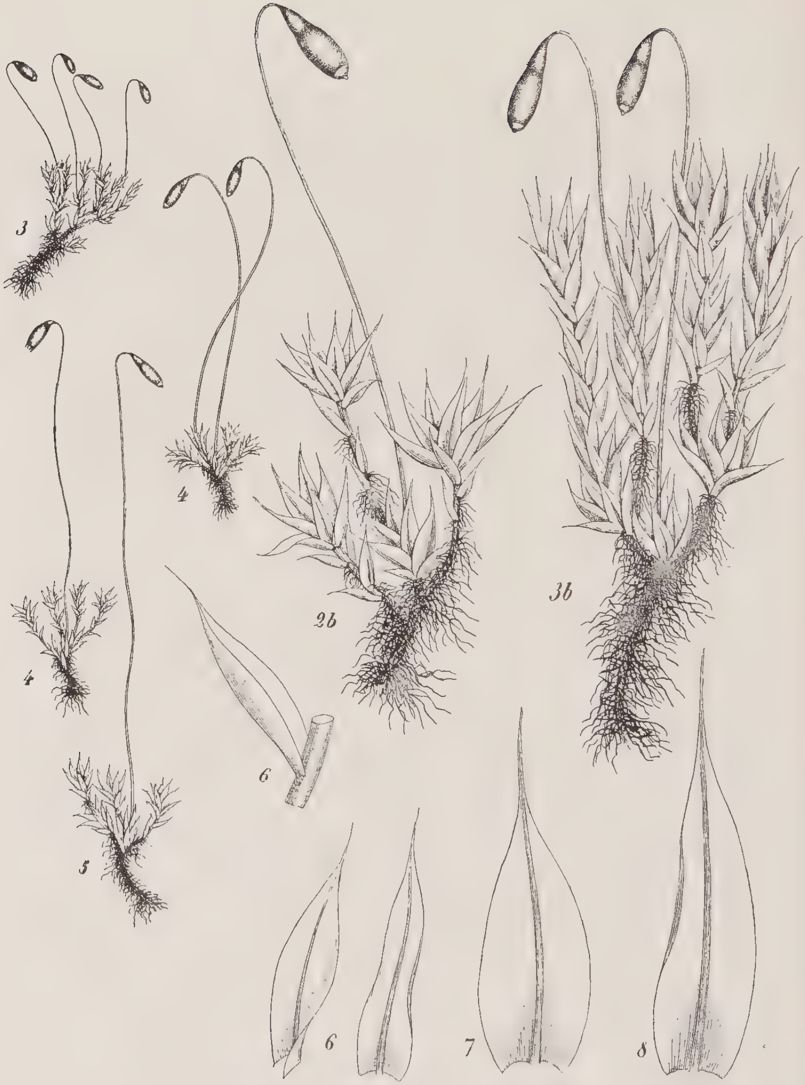

3
4
4
5
2b
3b
6
6
7
8

PLATE XLVI. *Bryum caespiticium* (From Bry. Eur.).

3, 4 and 5. Plants natural size. 2b. and 3b. Plants magnified. 6, 7 and 8. Leaves.

cover its stem. The leaves are rather distant, $^1/_{12}$ of an inch or more long, plainly bordered, with costa percurrent or excurrent, and red in old leaves. This species is exceedingly variable in size and general appearance and one who has collected it several times cannot feel sure that he will recognize it the next time he finds it. The spores mature in mid-summer.

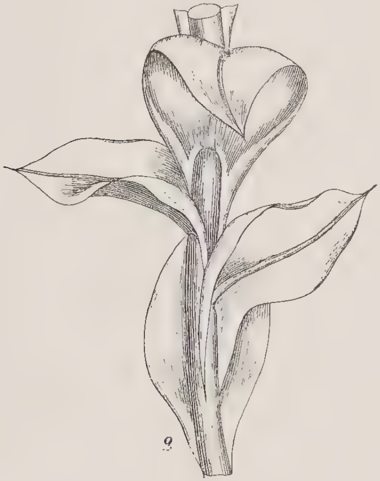


FIGURE 62.
Portion of stem of *Bryum Duvalii* much enlarged (From Bry. Eur.).

B. DUVALII Voit., the Winged Bryum, is a rare plant growing in elevated swamps, but is so peculiar as to be easily recognized even when sterile. The stems are slender and weak with leaves very far apart, much farther than the cut would indicate, and so strongly decurrent as to make the stem appear winged. They are scarcely margined, and the costa is not excurrent.

POHLIA NUTANS (Schreb.) Lindb., the Nodding Bryum, is one of the mosses most frequently sent me for determination. It grows everywhere in moist or swampy places on peaty soil, rotten wood, etc. The plants vary from ½ to 2 inches in height, rarely over an inch as I find them. The upper leaves are long and narrowly lanceolate, faintly serrate at apex, and not margined. The costa is strong and ends below the apex. With the lens the costa appears to be percurrent and the leaves entire. The spores mature in early summer. (Pl. XLVII.)

POHLIA LESCURIANA (Sulliv.) is a small plant ½–1 inch in height. The capsules are small and ripen in May; when fresh the bulging, knob-like lids are strikingly characteristic as shown in the photo-

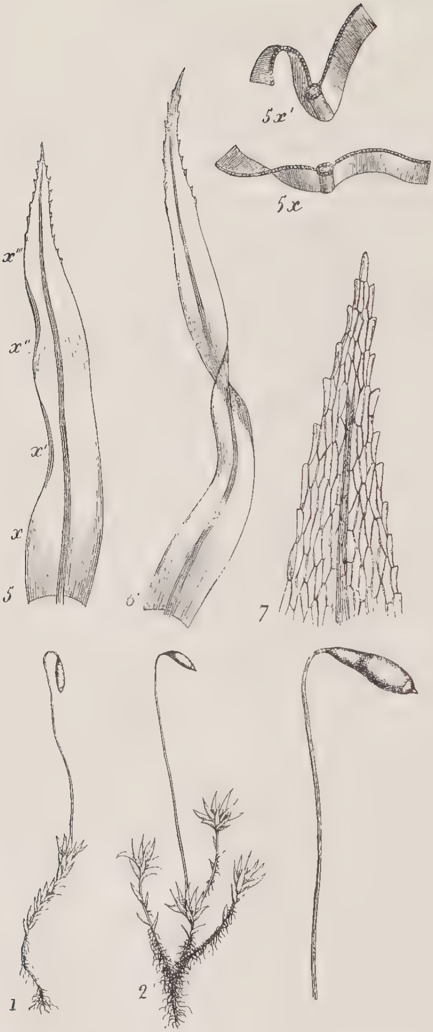

5x'
5x
x'''
x''
x'
x
5
6
7
1
2

PLATE XLVII. *Pohlia nutans* (From Bry. Eur.).

1 and 2. Plants natural size. The other figures are self-explanatory.

graph. When dry and empty the capsules are strongly contracted under the mouth. The leafy stems seem most often oblique and the setae vertical. The leaves are small and narrowly lanceolate. It grows in moist shaded places and is not rare in the vicinity of New York City.

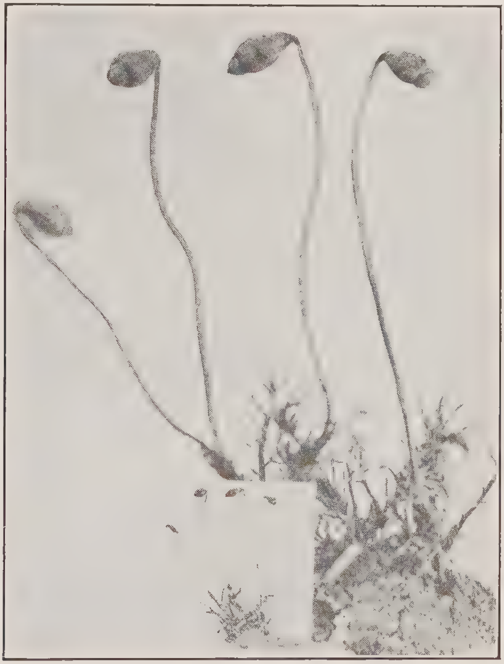


FIGURE 63.
Pohlia Lescuriana, × 1 and × 5.

POHLIA ELONGATA Hedw. is a rather rare moss found only in the mountains. It grows on damp soil in cool shaded places. It is at once known by the slender long-necked capsule which is never to be confused with the Long-necked Bryum because of the different position of its capsules and its broader, lanceolate leaves. The spores mature in August. (Fig. 64.)

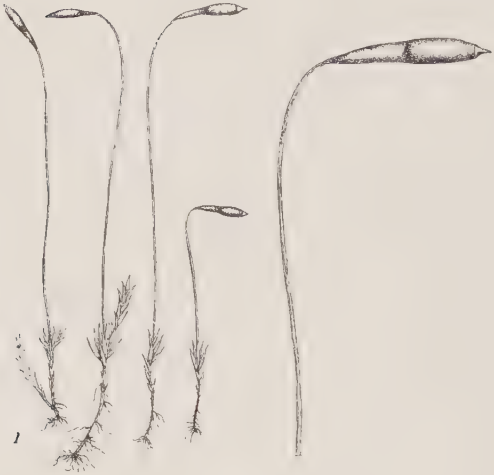


FIGURE 64.
Pohlia elongata, natural size and capsule enlarged (From Bry. Eur.).

LEPTOBRYUM PYRIFORME (L.) Wils., the Long-necked Bryum, is closely allied to the true Bryums, although placed in another genus. It is easily recognized by its long-necked capsule and slender hair-like leaves. The capsules mature in June and July.

Some species of *Pohlia* have very long-necked capsules, but the leaves are so much wider that there is no need of confusing them with the Long-necked Bryum.

This species is frequent on moist shaded cliffs and on rocks near water. It is not as rare as the author once thought, for it is frequent on damp mortared

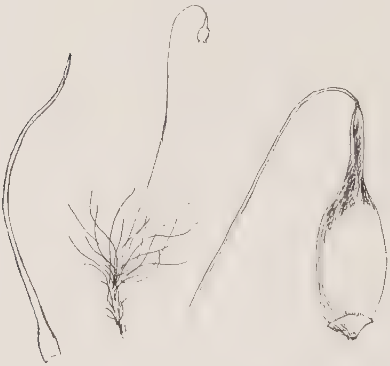


FIGURE 65.
Leptobryum pyriforme, × 2; leaf and capsule, × 10.

walls in various situations. The author has collected it on the basement of a Brooklyn house and in the cut which leads up to Montague Street from the Brooklyn end of the Wall Street Ferry.

MNIUM.

The Mniums are closely related to the Bryums, but in habit and general appearance are different enough so that they can usually be distinguished without difficulty. As a rule, the plants are larger and broader. The Giant Bryum, however, looks very much like the Mniums.

There are numerous species of Mnium, many of them common. We have about ten that are common enough and sufficiently well characterized to warrant description here.

KEY.

1.	Leaves margined	2.
	Leaves not margined	11.
2.	Leaves entire	3.
	Leaves serrate	4.
3.	Growing on rocks in the bed of brooks	*punctatum.*
	Growing on soil in shaded swampy places	*punctatum elatum.*
4.	Capsules clustered	8.
	Capsules single	5.
5.	Leaves serrate to base	*affine ciliare.*
	Base of leaves entire	6.
6.	Leaves oblong-lanceolate, 5:1	*hornum.*
	Leaves, oblong, rounded, or obovate	7.
7.	Mouth of capsule (peristome) red	*spinulosum.*
	Mouth of capsule not red	*sylvaticum.*
8.	Leaves tapering to the acute apex	9.
	Leaves obtuse and rounded at apex, mucronate by the excurrent costa	*rostratum.*
9.	Teeth at margins of leaf double; peristome red	*spinulosum.*
	Teeth at margin of leaf not double; peristome not red	10.
10.	Plants dioicous, with stolons	*affine.*
	Antheridia present at base of seta; stolons lacking	*Drummondii.*
11.	Plants very robust, resembling large forms of the Large-leaved Mnium	*cinclidioides.*
	Plants small	*stellare.*

M. CUSPIDATUM (L.) Leyss. (*M. sylvaticum* Lindb.), Woodsy Mnium. One of the first signs of vegetable life in early spring is the array of upright green sporophytes of the Woodsy Mnium, which is common in lawns and parks in moist shady corners, and is to be found abundantly in moist woods everywhere, growing, sometimes on the soil, sometimes on rotten wood. The capsules mature in May, but can be found in recognizable condition until August.

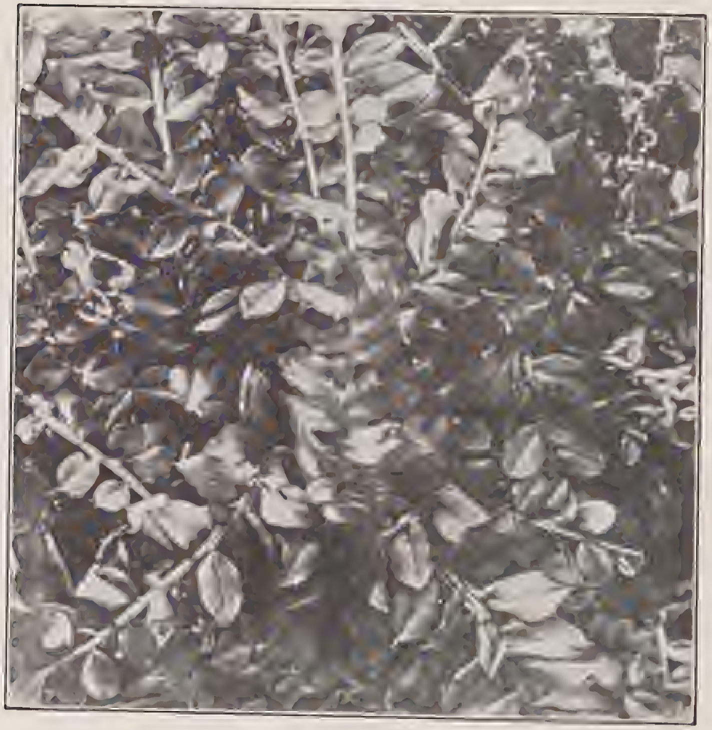


FIGURE 66.
Mnium cuspidatum, × 4. Stolons.

M. AFFINE CILIARE (Grev.) C. M., the Toothed Mnium, closely resembles the Woodsy Mnium in many respects, but is easily distinguished by the leaves. The leaves of the Toothed Mnium are serrate with very long and slender teeth, which extend to the base of the leaf. In the Woodsy Mnium the leaves are serrate with shorter teeth that do not extend much below the middle of the leaf. Until

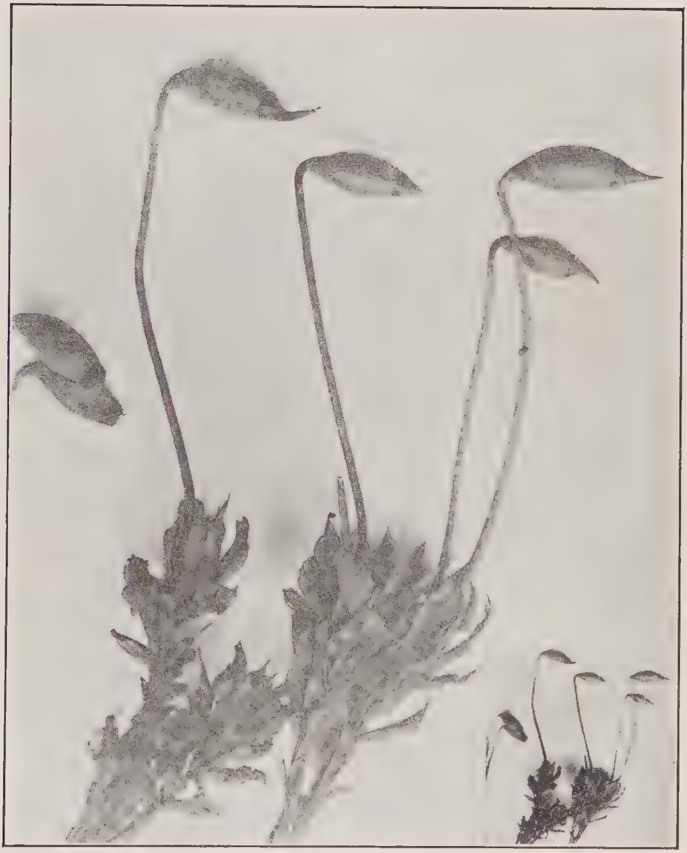


PLATE XLVIII. *Mnium spinulosum*, × 4; insert, × 1.

one has had some practice, it may be necessary to mount the leaves in order to see the serration plainly. No reliance should be placed on the shape of the leaves in distinguishing these two species, as the leaves vary greatly in shape in different plants and on different parts of the same plant.

M. AFFINE Bland. The common form of this species is the variety described above. The species is rather rare and is a puzzling form for the hand-lens student. The figures and description of *M. Drummondii* in the FIRST EDITION were based on this species largely. It has the capsules clustered, and teeth on the margins of the leaves shorter than in the Toothed Mnium. It is distinguished from *M. Drummondii* by the longer, less decurrent leaves, creeping stems, and by having antheridia and archegonia on separate plants. The male heads bearing antheridia can usually be found mixed with the plants bearing capsules.

M. DRUMMONDII B. & S., the true Drummond's Mnium, is infrequent. It is distinguished from *M. affine* by the characters given under that species. By carefully stripping off the perichaetial leaves and mounting them and the seta on a slide the presence of antheridia can usually be made out with a high power lens.

M. SPINULOSUM B. & S., the Red-mouthed Mnium, is a third species somewhat resembling the Woodsy Mnium and growing in similar situations, but less common and usually growing in woods. The peristome is a very bright red-brown, and after the operculum has fallen it makes a very conspicuous red band about the mouth of the yellowish-white capsule. If the leaves of the Red-mouthed Mnium be carefully studied, the teeth on the margins will be seen to be in pairs. To see this with a hand-lens requires considerable care, as the teeth are small and hide one another. The capsules mature at least two weeks later than those of the Woodsy Mnium. Before the lid has fallen its pronounced beak is an aid in identification. In Europe the capsules of this species are usually clustered, but in the eastern United States I find the great majority of plants with single capsules. The plants also seem rather smaller than the Western and European forms.

M. HORNUM L. There are several species of these double-toothed Mniums, but the only other one readily recognizable with a simple lens is the Long-leaved Mnium, whose leaves are proportionately much longer and narrower, with the costa ending below the apex. It is dioicous and the disc-like male heads are an additional aid in identification. This species is more abundant southwards and is

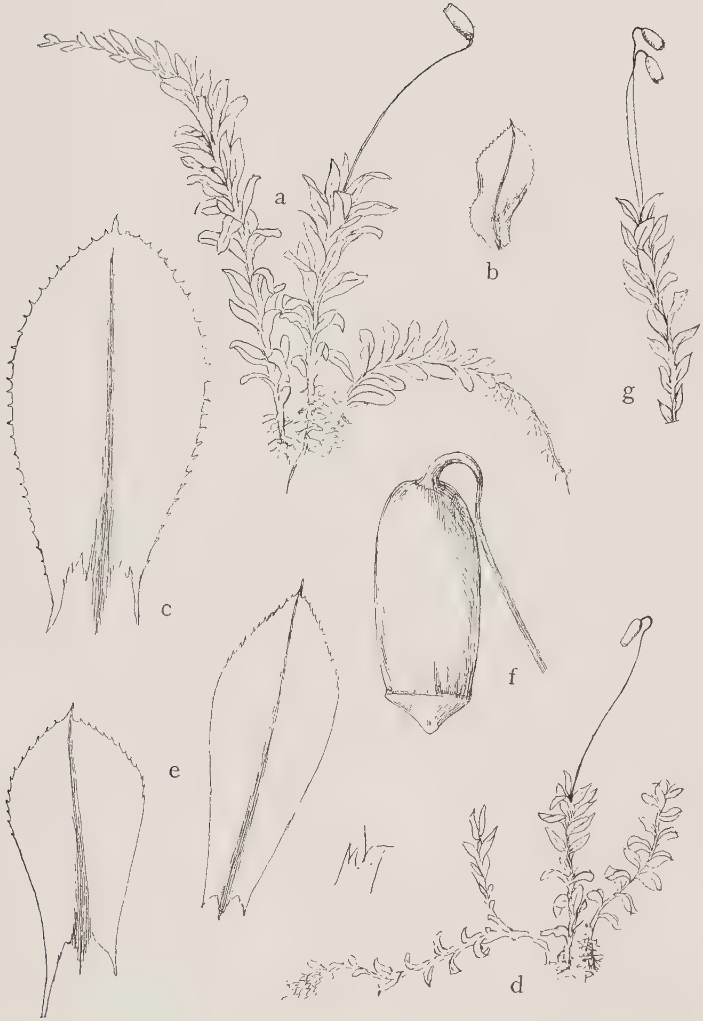


PLATE XLIX.

Mnium affine ciliare, × 1. b. Leaf, × 4. c. Leaf, × 10. d. *M. cuspidatum*. × 1. e. Leaves of different shapes, × 10. f. Capsule, × 10. g. *M. affine*, × 1.

frequent around New York City in shaded springy places. It does not appear to fruit freely, but if one can find fruit in April with the calyptra in its queer position on the seta, instead of on the capsule, he can make no mistake.

M. ROSTRATUM Schrad., the Beaked Mnium, is a fairly common species which seems to fruit infrequently. The leaves are oblong to obovate and rounded at the apex with the costa running abruptly out into a short point. They do not taper as in most species, but are rounded at apex into an outline nearly semicircular. The border is strong and the teeth single, sometimes rather short at the apex. The capsules are clustered and strongly beaked, as in the Early Mnium, but the plants seem to spread largely by stolons which form loose mats over the soil in moist shaded places. The antheridia are mixed with the archegonia. The spores mature in spring.

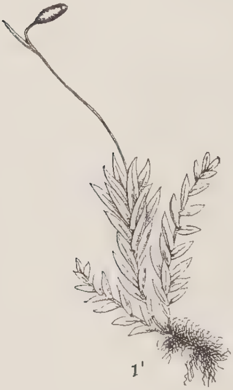


FIGURE 67.
Mnium hornum (From Bry. Eur.). Plant natural size.

M. PUNCTATUM L., the Early Mnium, grows on moist stones in the bed of shallow brooks. It matures its capsules in April, long before any other species. It is at once recognized by its obovate entire-margined leaves and beaked operculum.

M. PUNCTATUM ELATUM Schimp., the Large-leaved Mnium, is said to be merely a variety of the Early Mnium growing in the mud in swampy places. It is often much larger than the figure, sometimes having leaves half an inch long. The leaf cells are so large as easily to be seen with a lens and in some cases with the naked eye of a trained observer.

The leaves of this species and variety are obovate to almost circular and are very thin so that they greatly shrivel in drying. The leaves in the plants shown in fig. 66 were fully expanded and fresh when they were placed before the camera but in the few minutes spent in focussing they shrivelled as shown in the photograph. To support these large thin leaves they are surrounded by a strong thick border, which may be seen by holding the leaves up to the light.

Var. *elatum* is common in moist peaty swamps in woods. The plants are sometimes several inches high.

The two species without borders to the leaves are rather infrequent and so different as to remove all danger of confusion.

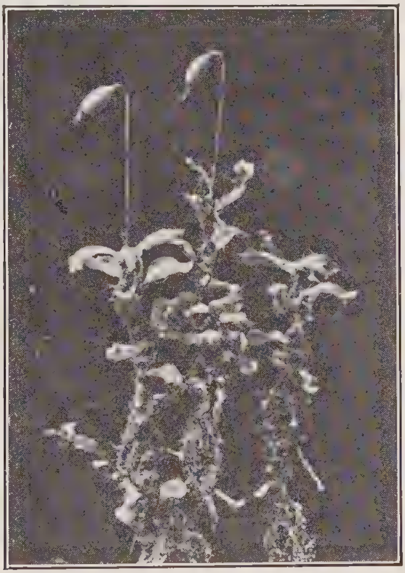


FIGURE 68.
Mnium punctatum.

M. CINCLIDIOIDES (Blytt) Hueben. is a very large moss four to six inches high, said to have been found a foot long, and looking almost exactly like an overgrown Large-leaved Mnium. The leaves are larger and oblong and when mounted show no trace of a border. This is a rare species of cool bogs.

M. STELLARE Reich. is a small moss usually less than an inch high, though sometimes becoming more than two inches in length. It grows in rather dense cushions at the base of trees in swampy woods. Although frequent it rarely fruits. The leaves are elliptic-oblong with no trace of margin and teeth too fine to be seen with a lens; the costa ends farther below the apex than in any other species included here.

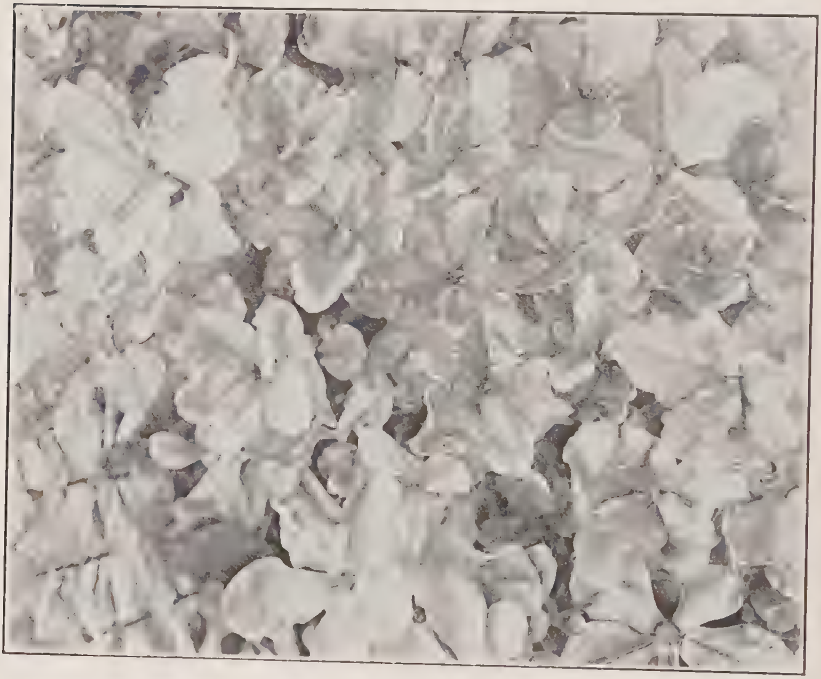


FIGURE 69.

Mnium punctatum elatum, × 1.

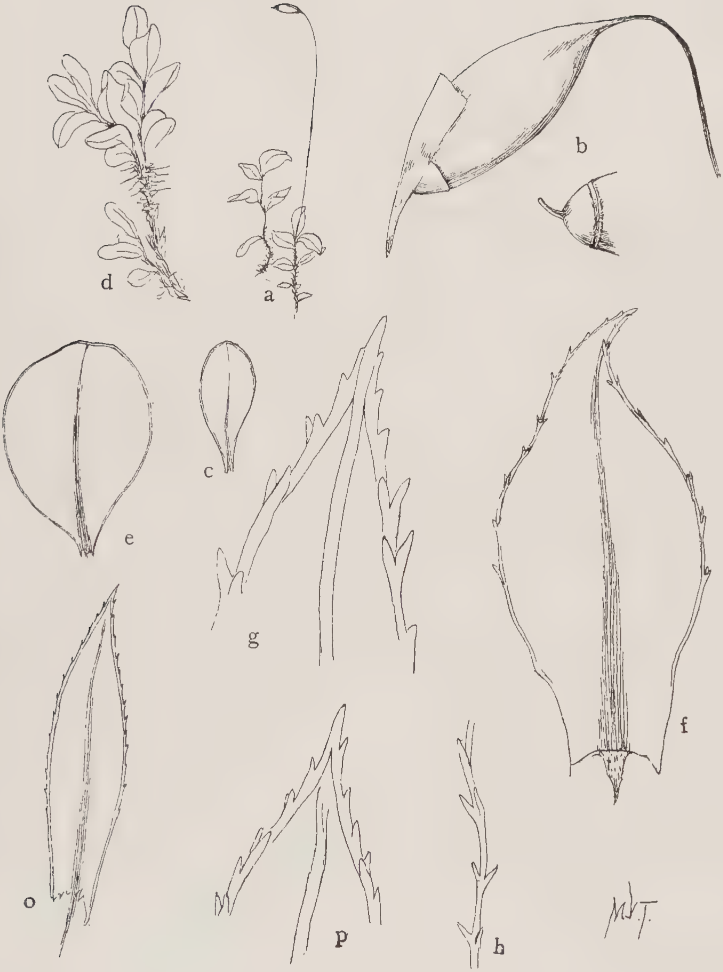


Plate L.

M. punctatum, × 1. b. Capsule and operculum, × 10. c. Leaf, × 4. d. Var. *elatum*, × 1. e. Leaf of var. *elatum*, × 4. f. Leaf of *M. spinulosum*, × 20. g and h. Apex and margin of same, × 40. o. Leaf of *M. hornum*, × 10. p. Apex of the same, × 40.

PLEUROCARPOUS MOSSES.

The remainder of the mosses have creeping stems, seta arising from short lateral branchlets and peristome double. Usually growing in intertangled mats.

FAMILY 8. LESKEACEAE. The Leskea Family.

All the members of this family except Thuidium have erect capsules, oblong to cylindrical, sometimes larger at base. The leaf cells are so strongly covered with little projections as to make them less transparent than in most other pleurocarpous mosses. The Twisted Mosses, it will be remembered, had leaves that were subopaque for the same reason.

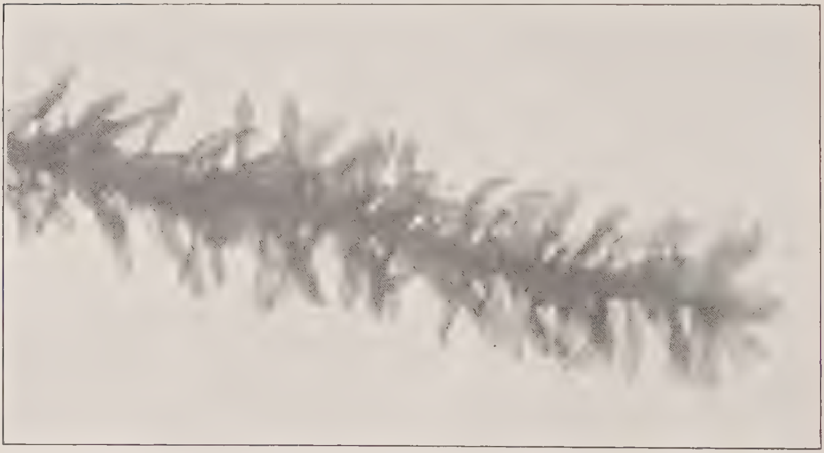


FIGURE 70.

Anomodon minor, × 8, by transmitted light.

ANOMODON. Hook. & Tayl.

The bases of trees in cool moist woods frequently wear an apron of dark green, extending from the roots to three or four feet above the ground and often entirely encircling the trunk. This "apron" is usually composed of one or more species of Anomodon, often mixed with an Hepatic (*Porella*). The mats of Anomodon are quite thick and are composed of a network of nearly leafless stems growing close to the bark and sending out the crowded branches that compose the "pile" of the mat. The Anomodons are nearly all rather coarse mosses with the sporophyte arising from the *branches*. The capsules are conic-cylindrical, straight and erect.

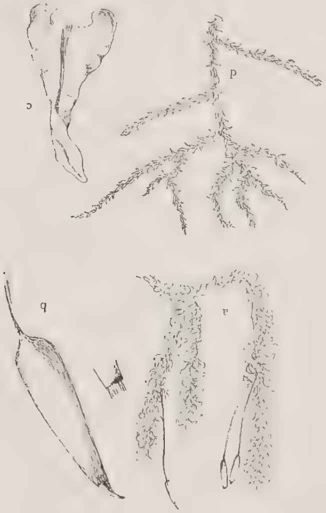


FIGURE 71.

a. *Anomodon apiculatus*, × 2. b. Capsules, × 10. c. Leaf, × 10. d. Branch of *A. attenuatus*, moist, × 2.

Some species of Leskea grow in similar situations and have a very similar sporophyte, but the Leskeas are much smaller, do not produce such dense mats, and the sporophyte arises from the *stem*.

There are three species of Anomodon growing on trees as described above. The Common Anomodon, the Blunt-leaved Anomodon, and the Slender Anomodon. All these have the branches flattened as shown in fig. 70.

A. APICULATUS B. & S., the Common Anomodon, and *A. minor* (P. Beauv.) Fuern., the Blunt-leaved Anomodon, resemble each other so closely that it is not easy to distinguish them without a compound microscope. Both have simple blunt branches, tongue-shaped leaves, and grow almost exclusively on trees.

A. ATTENUATUS (Schreb.) Hueben., the Slender Anomodon, grows freely on rocks as well as trees; its branches are slender and tapering, and freely branched. The leaves are narrower. It almost never fruits.

A. ROSTRATUS (Hedw.) Schimp. grows in dense mats like a very coarse velvet. It is bright yellowish-green above, brownish below, found in wet places, particularly at the foot of trees in swamps, growing on the ground rather than the tree. It is also common at the base of wet cliffs and on wet rocks where a little soil has collected. The leaves are different from those of any of the other species and are easily recognized, when mounted, by the slender hair-like apex. The spores are ripe in late autumn.

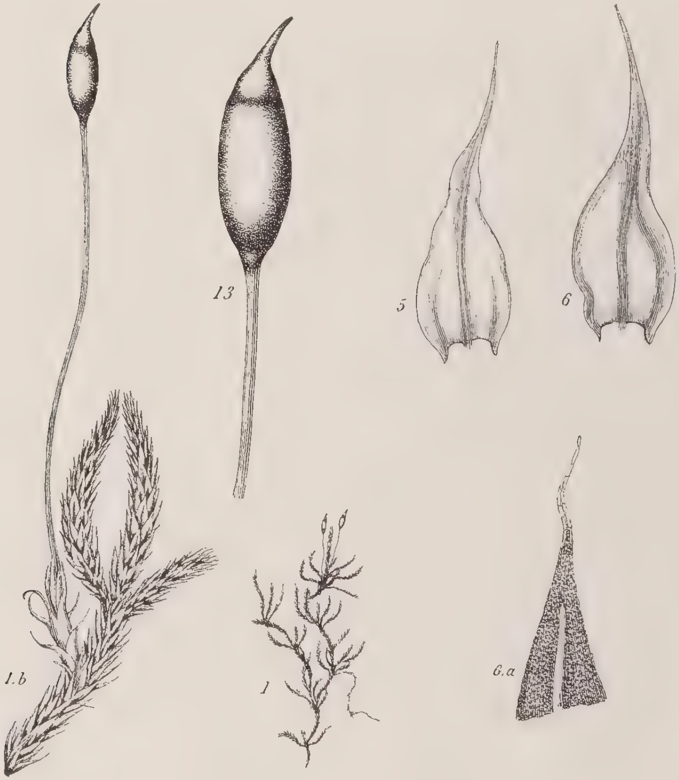


FIGURE 72.

Anomodon rostratus (From Bry. Eur.). 1. Plant natural size.

THÈLIA.

Thelia hirtella (Hedw.) Sulliv., the Common Thelia, is very common in the southern and coastwise portion of our range. It grows almost exclusively on the bark of stumps and the bases of trees. It forms thin closely adherent mats, easily recognized by their whitish-green color, erect symmetric capsules *with whitish peristome*, julaceous branches, and concave suborbicular minute leaves. The capsules mature in autumn.

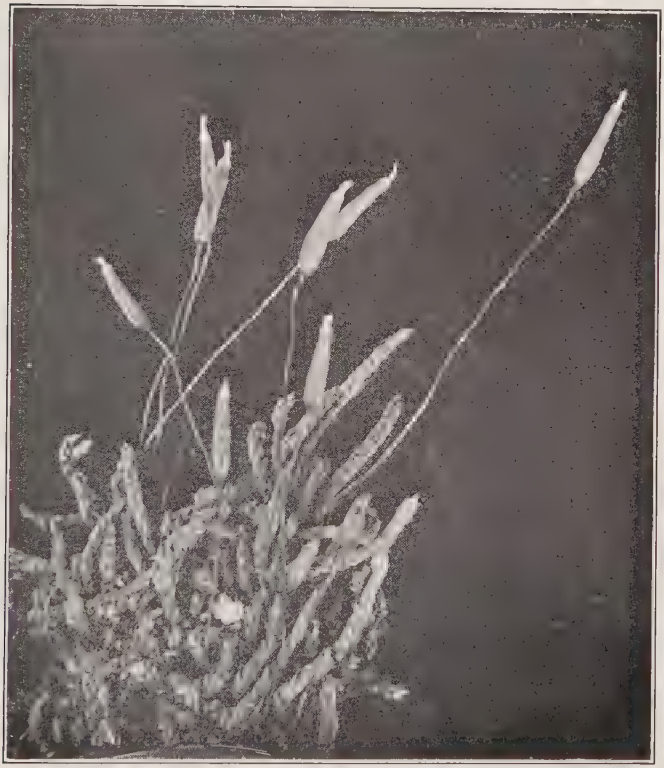


Figure 73.
Thelia hirtella, × 5.

Thelia asprella (Schimp.) Sulliv. has a range and habitat very similar to that of *T. hirtella*, but is even lighter in color; when fresh, light glaucous-green. *T. Lescurii* Sulliv. is very similar to the above-named species, but grows in rather *dry soil*. It is confined to the more southern coast regions (northern limit Connecticut). It rarely produces capsules, while the other species fruit freely.

THUÍDIUM. The Fern Mosses.

The Fern Mosses have been noted by every lover of out-of-door life because of their delicate and beautiful fern-like form. The branches are given off very regularly like the pinnae of a fern, and the branches themselves often give off branchlets as regularly as the pinna of a fern is divided into pinnules. Capsules cylindrical and curved like a bow.

T. scitum (Beauv.) Aust., the Smaller Fern Moss, is the one most likely to be met with, especially in the northern portion of our range. The capsules, besides being much smaller than in the Common Fern Moss are only slightly cernuous and are nearly symmetric. The capsules mature in autumn.

T. abietinum (L.) B. & S., Wiry Fern Moss, is another simply pinnate species that is common. This moss is most frequently found in dry sterile places on the ground among the grass, and on ledges. It varies considerably in appearance according to habitat and its immediate condition as to moisture. Usually it is very evenly and regularly pinnate. Though frequent, it is very rarely found fruiting in our latitude. Mr. R. S. Williams, however, found it fruiting freely in Alaska. Mr. Williams also reports several other similar cases, one of the most conspicuous being *Hypnum rugosum* L.

T. delicatulum (L.) Mitt., the Common Fern Moss, grows in damp shady places over stones and earth, rotten logs and the like. It is very regularly twice or even thrice pinnate. It grows abundantly in suitable situations throughout our range, but produces capsules rather sparingly. These mature in early autumn and are very large, much curved, and are borne on long stout setae. The perichaetial leaves bear long cilia along their upper margins. This is one of the characters by which this species can be distinguished readily from another closely related species, *T. recognitum.*

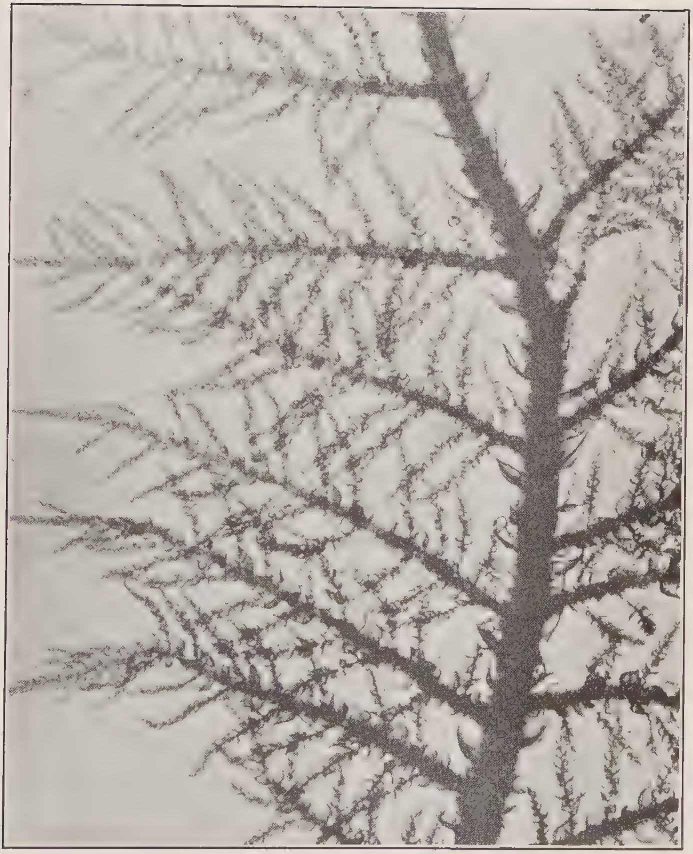


PLATE LI. *Thuidium delicatulum*, × 9, by transmitted light.

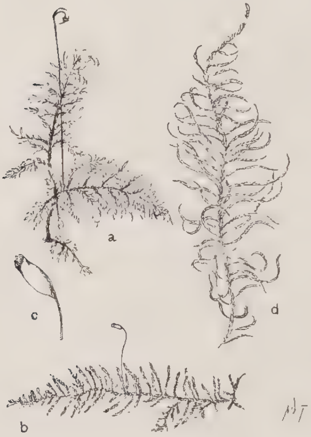


FIGURE 74.

a. *Thuidium delicatulum*, × 1. b. *T. scitum*, × 1. c. Capsule of the same, × 5. d. *T. abietinum*, × 1.

T. RECOGNITUM (Hedw.) Lindb. will not be distinguished from the Common Fern Moss except by close scrutiny. The perichaetial leaves are not ciliate and the stem leaves when moist are spreading-recurved instead of erect-spreading, as in the Common Fern Moss.

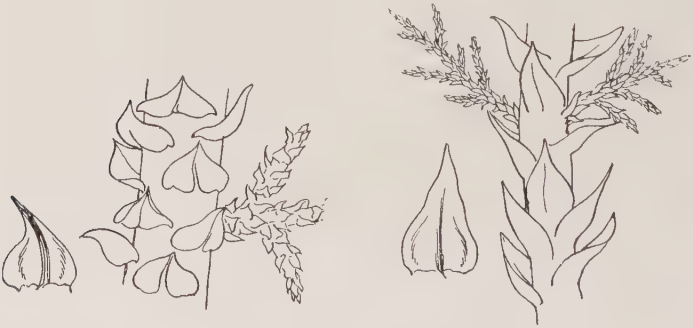


FIGURE 75.

Portion of stem and leaves of *Thuidium recognitum*, at the left. Same of *T. delicatulum*, at the right.

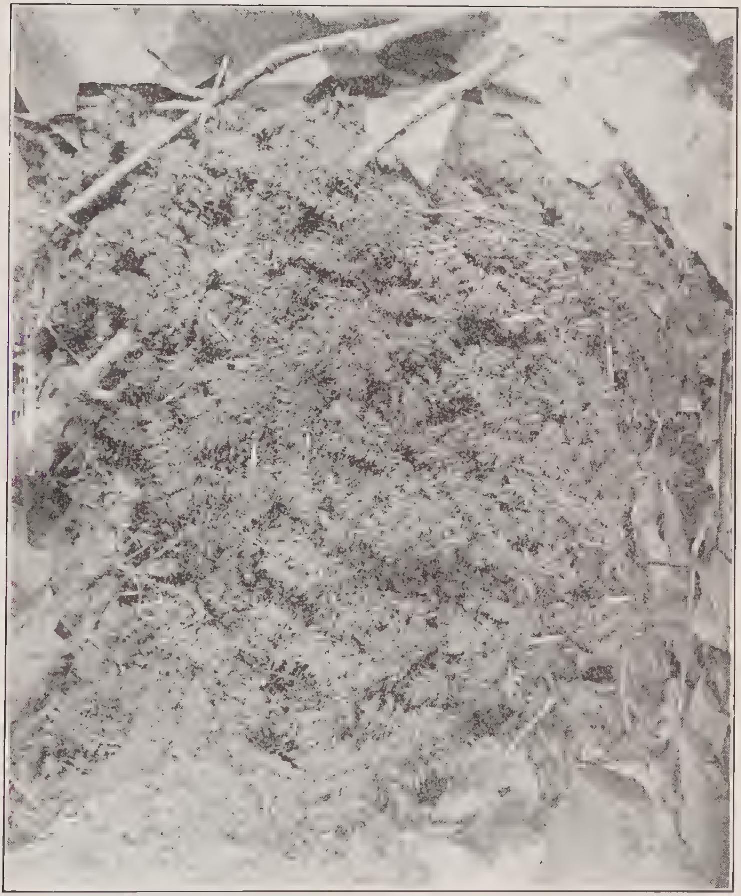


Plate LII.

Thuidium delicatulum in situ, slightly reduced.

The shape of the stem leaves is also different; the figures explain these differences better than any description. Both species grow on the ground, stones, or rotten wood, but this matures its spores in July, the other in early winter.

Growing on the bark of trees are several smaller species that are usually only once pinnate.

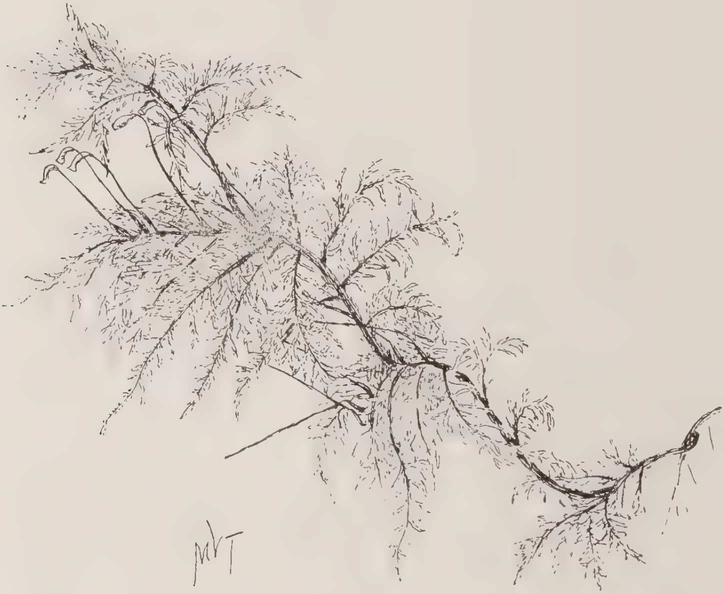


FIGURE 76.
Hylocomium proliferum, × 1.

HYLOCOMIUM PROLIFERUM (L.) Lindb. (*H. splendens* of many authors), the Mountain Fern Moss, although belonging to a different genus from the other fern mosses, is best treated in connection with them because of its similarity in form. As will be seen by the figures it is much larger and has a very peculiar and characteristic habit. Every year each of the main shoots of the previous year develops a single fern-like shoot from the middle of the upper side instead of branching out from the side of the shoot as in the case of most mosses. This gives the plant its peculiar habit and its botanical

PLATE LIII.

Upper, Old fronds of *Hylocomium proliferum*, × 1. Lower, Young "fronds" of *Hylocomium proliferum*, × 1.

name of "*proliferum.*" It is one of the too rare cases in which the botanical name is descriptive of the plant to which it is applied.

This moss grows abundantly in cool moist mountain woods on stones and old logs. When found growing elsewhere it is so stunted as to give no idea of its beauty in its favorite habitat. The capsules, which mature in autumn, though not rare, are sparingly produced in proportion to the number of plants. When a patch does fruit, however, it often fruits heavily.

FAMILY 19. HYPNACEAE. The Hypnum Family.

The preceding species belongs to the great Hypnum Family, which contains a vast number of our common mosses. The majority of the members of this family are slender and prostrate, or creeping with ascending branches. The sporophyte varies a good deal, but the capsules are more or less unsymmetric and cernuous in most species. The members of this family usually grow in dense thin mats on soil, stones, rotten wood, and bark of trees. There are hundreds of species belonging to this family and the number within our own range is very large. Many of the species and even genera are so closely related and are distinguished by so few and so minute differences that no one but a trained and expert student of mosses can name them correctly. For this reason only a few of the most strongly marked species can be treated here. This is to be regretted, for many of the commonest mosses will thus be omitted and the student will be discouraged by finding so many things that he cannot identify. It is safe advice to the beginner to leave the Hypnums until he has studied the more easily recognized mosses.

Roughly, the more common genera are distinguished thus· Plagiothecium and Entodon are flattened in a plane parallel to the substratum, but the capsules of Entodon are erect and symmetric, while those of Plagiothecium are curved and cernuous. Brachythecium has very short ovoidal capsules that are cernuous and somewhat curved (except *B. acuminatum* and *B. oxycladon*); the leaves have a strong midrib. *Eurhynchium*, *Cirriphyllum*, and *Rhynchostegium*, have the strong midrib and short capsules of *Brachythecium*, but the opercula are grotesquely long-beaked, much as in *Dicranum*. *Hypnum recurvans* has long-beaked capsules like the three genera mentioned above, but the leaves lack the midrib. *Pylaisia* grows exclusively on the bark of trees, and is dark green; the short branches are strongly curved at the end when dry, and the capsules are erect and symmetric. *Hypnum* has so many varying forms that one can best get an idea of it from studying the individual species described below.

Nearly all the genera of the family were formerly included in the genus Hypnum and the appearance of the species throughout the family nas such a similarity that Hypnum can appropriately be used for the common name of many species scientifically included in other genera. Also it will frequently be more helpful to group species from different genera with a similar appearance rather than to put all species of a genus together.

KEY TO THE HYPNUM FAMILY.

1.	Leaves strongly turned to one side (secund)	2.
	Leaves not secund	8.
2.	Leaves with a midrib	3.
	Leaves without midrib	4.
3.	Plants very robust, never fruiting; leaves wrinkled crosswise	*Hylocomium rugosum.*
	Plants slender to moderately stout; leaves often wrinkled lengthwise, never crosswise	Hooked Mosses.
4.	Capsules wrinkled lengthwise when dry	*Hypnum curvifolium* and *H. Patientiae.*
	Capsules not appreciably wrinkled when dry	5.
5.	Capsules long-beaked; alar leaf cells much enlarged and hyaline	*Hypnum recurvans.*
	Capsules not long-beaked; alar cells not much enlarged	6.
6.	Plants plume-like; capsules strongly curved	*Hypnum Crista-castrensis.*
	Plants pinnately branching but less plume-like; capsules erect or only slightly curved	7.
7.	Plants slender, dry capsule with mouth oblique	*H. reptile.*
	Plants more robust, almost always on rotten wood; mouth of dry capsule not oblique	*H. imponens.*
	Plants growing on stones in cool brooks	*H. ochraceum.*
8.	Growing in water	Water-loving Hypnums.
	Growing in various situations, often in wet places but not in water	9.
9.	Leaves with midrib; capsules very short and stout, not more than three times as long as broad	*Brachythecium* and the Beaked Mosses.

	Leaves with midrib; capsules more than 3:1	10.
	Leaves without distinct midrib	11.
10.	Plants large, with a treelike habit; leaves appressed when dry; capsules cylindric and straight	*Climacium.*
	Plants stout, suberect; leaves spreading when dry; capsules curved	*Hylocomium triquetrum.*
	Plants slender, creeping	*Amblystegium* and *Hypnum chrysophyllum.*
11.	Capsules erect and cylindric	15.
	Capsules more or less curved	12.
12.	Capsules wrinkled when dry	*Plagiothecium striatellum.*
	Capsules smooth when dry	13.
13.	Leaves appearing flattened into two ranks	*Plagiothecium.*
	Leaves not flattened into two ranks	14.
14.	Plants bright golden green, usually growing on soil	*Calliergon Schreberi.*
	Plants green, usually growing on decaying wood	*H. Haldanianum.*
15.	Plants usually growing on bark of trees.	*Amblystegium adnatum* and *Pylaisia.*
	Plants usually growing on soil or decayed wood or over stones	*Entodon* and *Hypnum Haldanianum.*

HÝPNUM.

AND CLOSELY ALLIED MOSSES.

In one section of this composite genus the leaves are all turned to one side (secund), and the branching is more or less regularly pinnate, giving the plants a plume-like appearance in many cases. The leaves are without midrib. This section is often called *Hypnum* proper. Two of the most common and easily recognized mosses of this group are the Plume Moss and the Pinnate Hypnum.

H. Crista-castrensis L., the Plume Moss, is common on decayed wood and stumps in cool moist woods in New England and New York, and probably throughout our range. A few starved specimens have been collected on Long Island. To be appreciated this moss should be seen in the cool moist recesses of the primeval mountain forests, where it covers the fallen and decaying trunks of huge trees with ample robes of richest texture. The shoots are ascending and as regularly pinnate as any feather, even to the

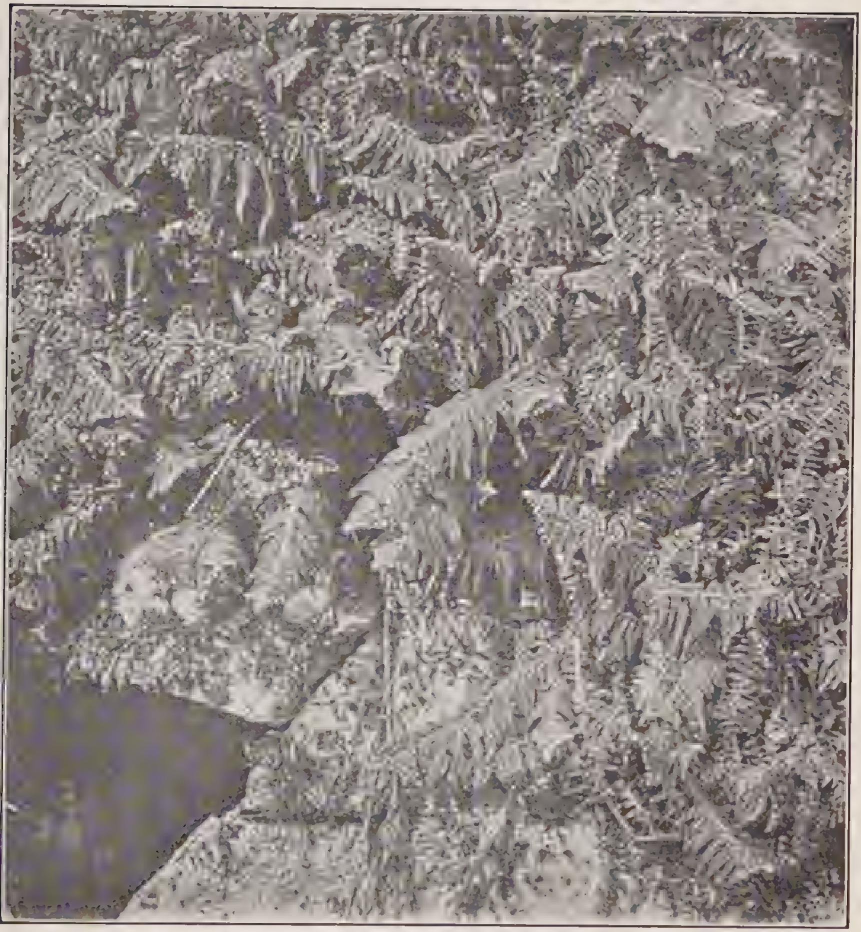


Plate LIV. *Hypnum Crista-castrensis*, × 1.
Photo by D. Lewis Dutton.

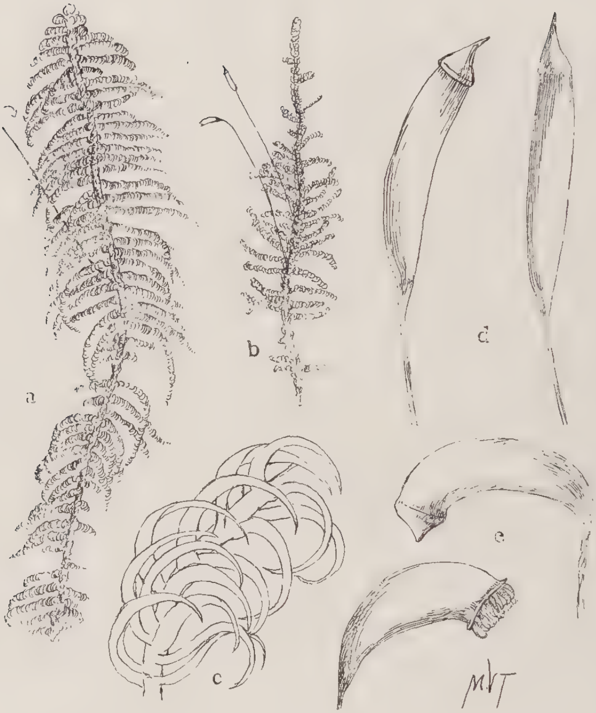


Figure 77.

a. *Hypnum Crista-castrensis*, × 1. b. *H. imponens*, × 1. c. Portion of branch of *H. Crista-castrensis*, × 10. e. Capsules, × 10. d. Capsules of *H. imponens*, × 10.

triangular apex of the shoot. Its color is a light yellow-green. Its capsules are strongly curved and cernuous; they mature in autumn.

H. imponens Hedw., the Pinnate Hypnum, is a much more common moss in the lowlands and grows almost exclusively on rotten wood in moist shady places. It somewhat resembles the Plume Moss, but is prostrate, forming dense closely cohering mats. It is also darker green; the capsules are nearly erect and symmetric, and the pinnate branching stops short of the apex of the shoots, as is shown in the figure. A careful examination will show that there is a difference in the curvature of the leaves; in the

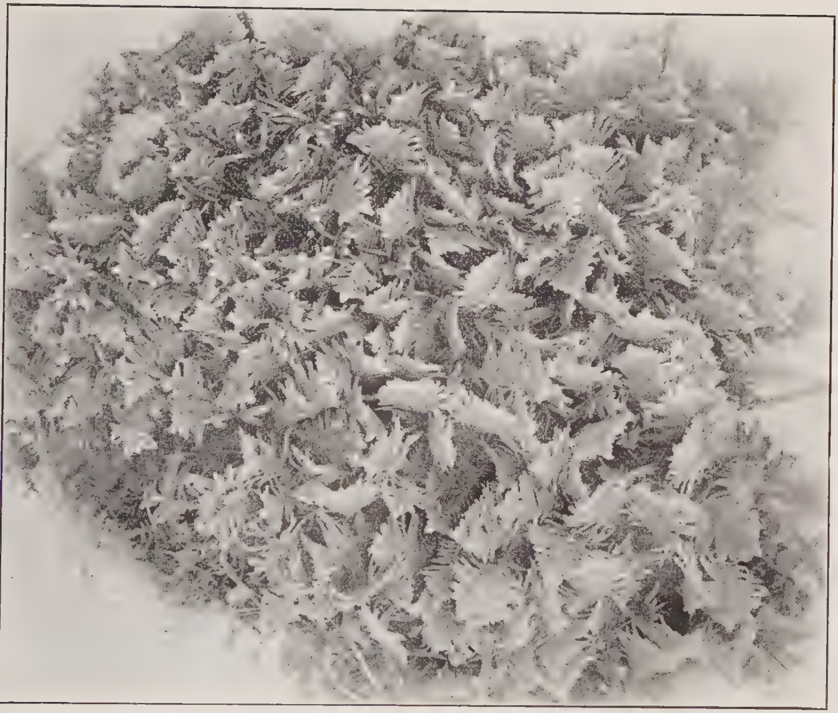


Plate LV.

Hypnum Crista-castrensis (slightly reduced).

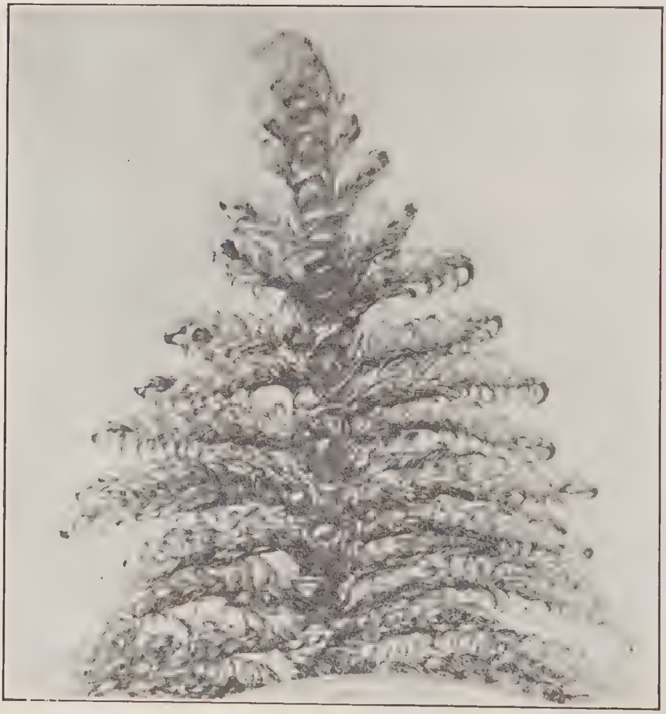


Plate LVI.

H. Crista-castrensis, × 9.

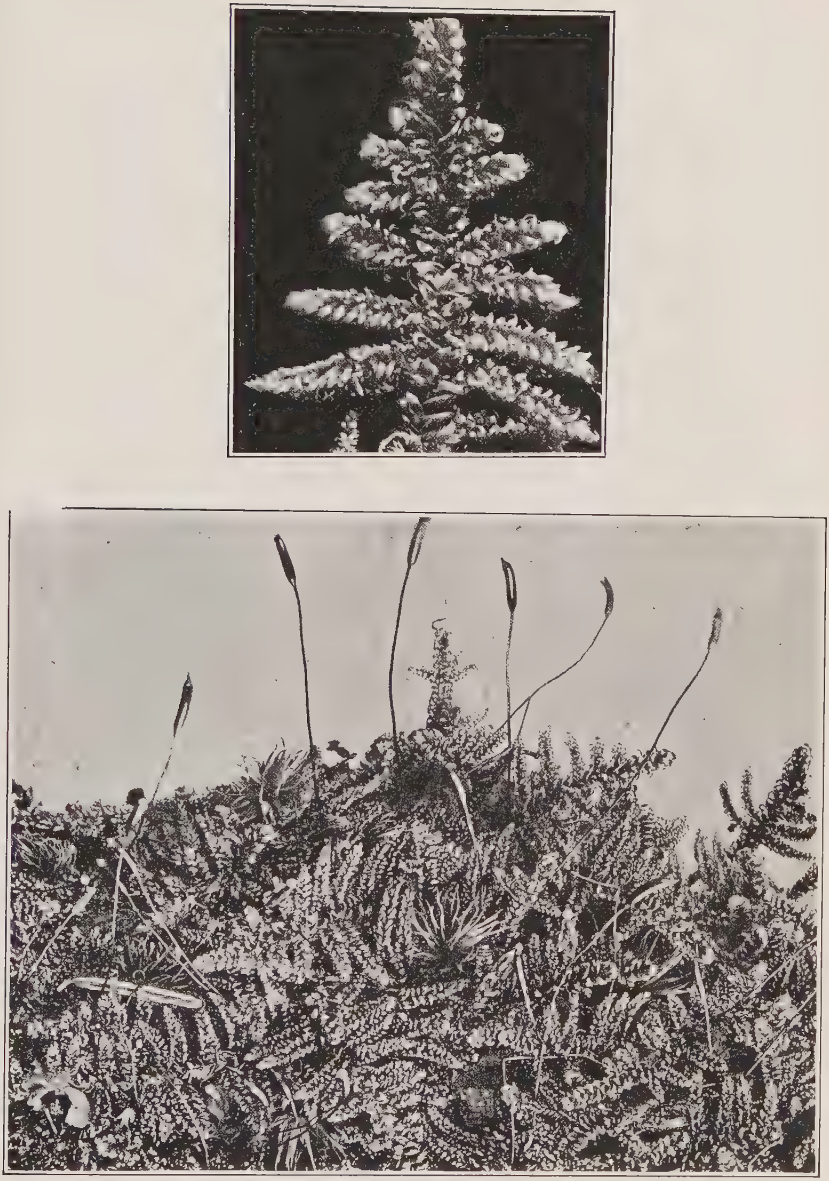


Plate LVII.
Hypnum imponens, × 2. (below). (Above) Spray, × 7.

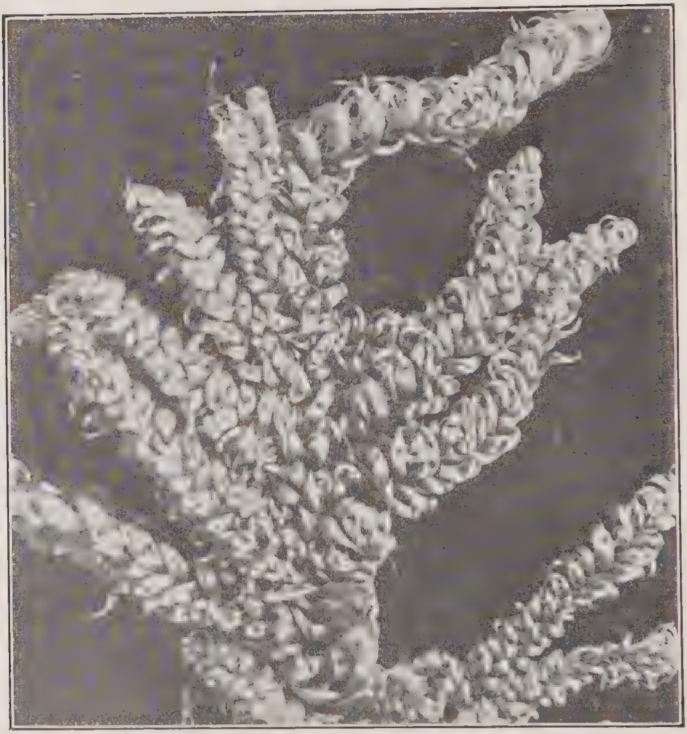


FIGURE 78.
Hypnum curvifolium, × 7.

Pinnate Hypnum the leaves curve towards the substratum at right angles to the plane of the stem, while in the Plume Moss they curve towards the branch next below on the stem. The capsules of the Pinnate Hypnum are produced much the more freely; they mature in winter, but persist in good condition for a long time. (Pl. LVII and Fig. 77.)

HYPNUM CURVIFOLIUM Hedw. is a much rarer moss that somewhat resembles *H. imponens* when sterile. It usually grows on moist soil and stones, is more confined to the mountains, is larger, lighter colored, and has curved cernuous capsules that are very strongly furrowed when dry. The leaves when dry are so regularly arranged as to give a characteristic appearance like a carefully dressed braid of hair.

H. PATIENTIAE Lindb. has furrowed capsules almost like those of the preceding and its general appearance is so similar that it is often hard to separate the two. In this species, however, the branching is irregular and the leaves do not have the peculiar braided look of the preceding.

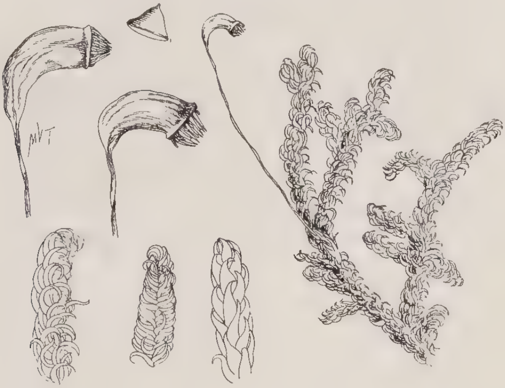
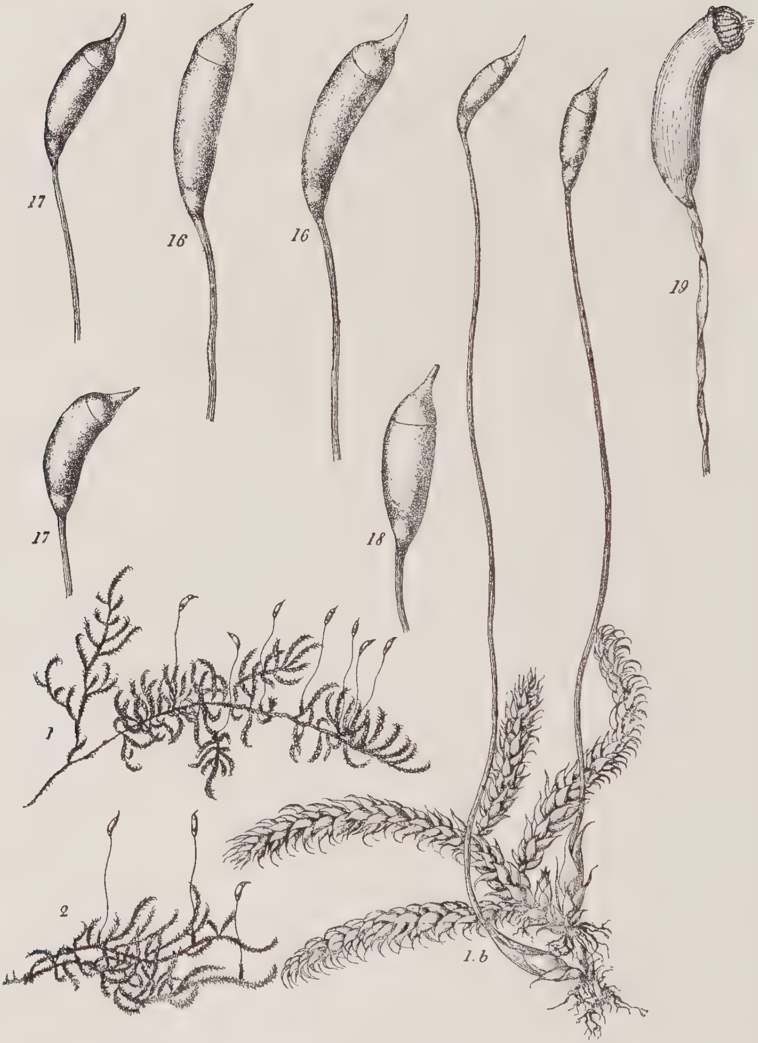


FIGURE 79.

Hypnum curvifolium, × 2; tips of branches, × 4; and capsules, × 4.

HYPNUM REPTILE Mx. is another almost regularly pinnate moss of this group, but it is less than half the size of the three described above. Its general appearance is also fairly well represented in Fig. 72b, but the capsules are longer and more curved. With a lens the leaves of the *Thuidium* will be seen to be acute and straight, while those of the *Hypnum* are curved and long-acuminate. The *Thuidium* grows in thin mats so that its pinnate character is easily seen at a glance; the *Hypnum* grows in such densely interwoven mats that it is often necessary to disentangle it before its pinnate character becomes apparent. *Hypnum reptile* matures its capsules much earlier than any of the three other species mentioned above. They are usually fully ripe in August, and when dry and empty the mouth becomes oblique, almost as much so as in *Dicranella heteromalla*. Even if the capsules dry with the lid on, the mouth


17
16
16
19
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18
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1. b

PLATE LVIII. *Hypnum reptile* (From Bry. Eur.).

1 and 2. Plants, natural size. Erect capsules like 18 are rare. 19 does not show the mouth oblique enough to be typical.

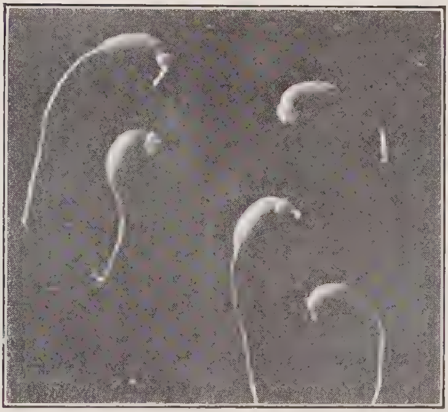


FIGURE 80.
Dry capsules of *Hypnum reptile*, × 5.

takes the oblique position strongly enough to be noticed. This obliquity of the mouth is not clearly shown in the figure.

AMBLYSTEGIUM ADNATUM (Hedw.) J. & S. is another species resembling *H. reptile* and often associated with it, especially on the bases of trees, but the leaves are not curved and the capsules are nearly straight and suberect.

H. RECURVANS (Mx.) Schwaegr. (the Common Raphidostegium of other editions) has irregular branching and secund ecostate leaves. It is a *bright yellow-green* and grows in dense mats on rotten stumps and logs in wet shaded places. It is common throughout our range, but I have rarely seen it in fruit in the vicinity of New York City. The chief distinction from the other Hypnums lies in the very short capsules with lid *very long-beaked*, and the enlarged alar cells like those of *Hypnum Haldanianum*. Until one becomes familiar with it, it is hard to recognize unless in fruit. The capsules mature in autumn and are often produced in great profusion. (Fig. 81.)

H. HALDANIANUM Grev., the Common Hypnum, is almost sure to be found in any moist shady place where decaying wood is present, covering the unsightly masses of rotten wood with its upholstery of bright green. Occasionally it grows on soil rich in humus. It is one of our commonest mosses and nearly always fruits freely.

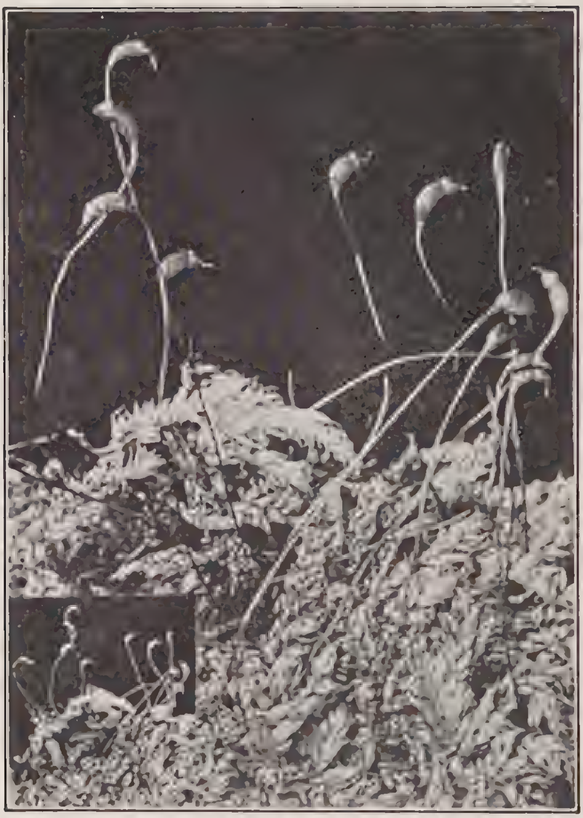


FIGURE 81.
Hypnum recurvans, × 5.

The Common Hypnum in appearance is very little like the species previously described; the leaves are straight and equally spreading on all sides, not secund. When mounted and examined with a high-power lens the abruptly enlarged cells at the basal angles are very conspicuous and render the determination certain. The capsules are cylindrical and somewhat curved, much like

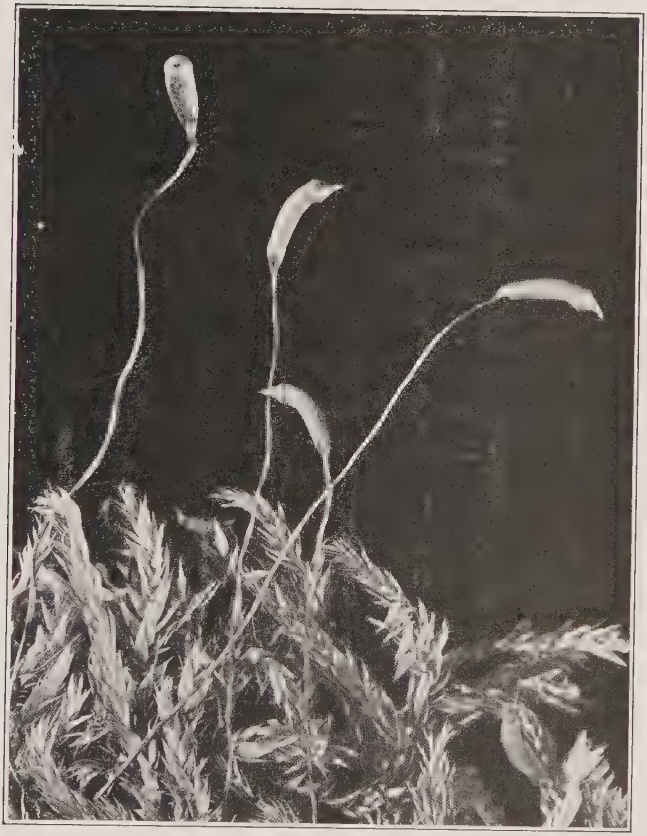


PLATE LIX. *Hypnum Haldanianum*, × 5.

those of the Pinnate Hypnum, only larger. They mature in late autumn or winter, but remain in fairly good condition until the next summer.

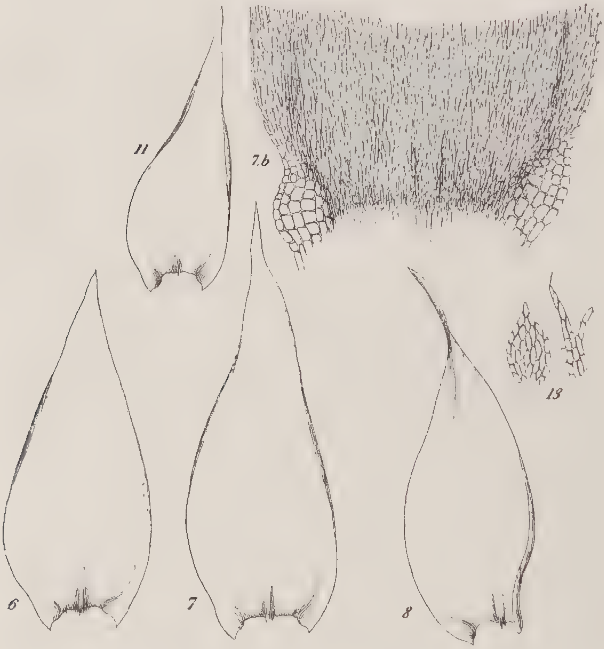


FIGURE 82.

Hypnum Haldanianum. 6, 7, 8 and 11. Leaves. 7b. Base of leaf showing enlarged cells at basal angles. 18. Paraphyllia (too small to be seen with the lens) (From Bry. Eur.).

BRACHYTHECIUM OXYCLADON (Brid.) J. & S., the Long-capsuled Brachythecium, sometimes grows on decaying wood and then is scarcely to be distinguished from the Common Hypnum with certainty unless the leaves be examined with a high-power lens, when they will be seen to have a strong midrib, and no enlarged cells at basal angles. The capsules are usually much darker than those of the Common Hypnum. The usual habitat of the Long-capsuled Brachythecium is on moist ledges and rocks.

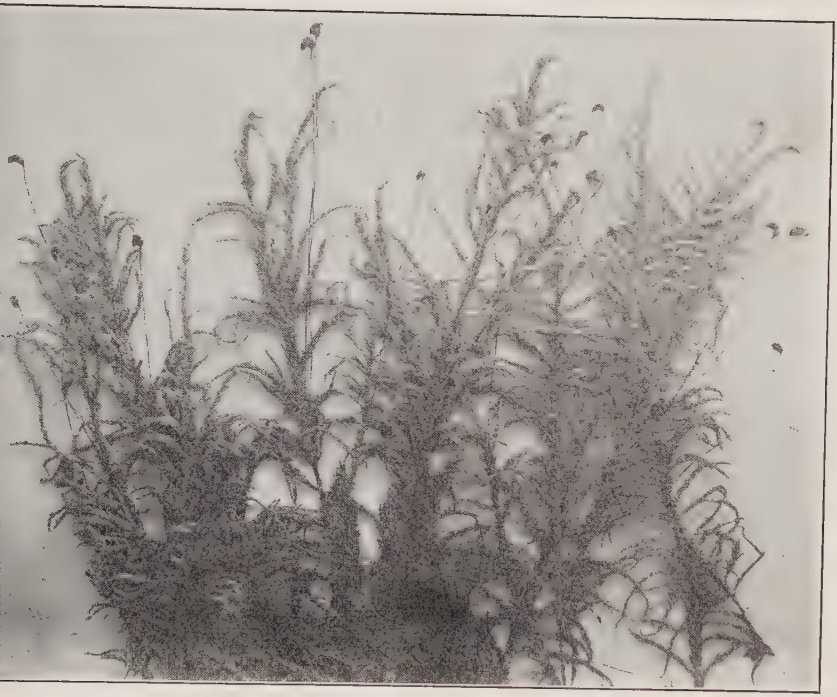


Plate LX.

Calliergon Schreberi, × 1.

Calliergon Schreberi (Willd.), Schreber's Hypnum, is the bright yellow-green moss that forms dense deep cushions by almost every moist shaded roadside in inland country regions. It is abundant in moist pastures and open woods, and sometimes makes its most luxuriant growth in a sphagnum bog. It is so common, so conspicuous, and withal so large, that every one must have noticed it at some time or other. The stems are often four to six inches long and nearly erect, and crowded so closely together as to form dense soft cushions into which the foot sinks deeply. Examined closely, the stems appear a bright red through the semi-transparent leaves.

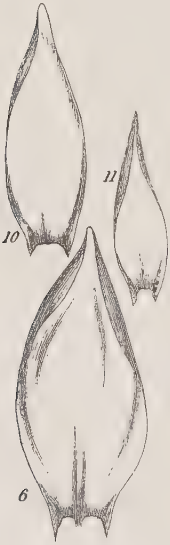


Figure 83.
Leaves of *C. Schreberi*
(From Bry. Eur.).

Schreber's Hypnum has broad obtuse leaves incurved at apex and very concave, and is put by some botanists in a subgenus of Hypnum, by others in Hylocomium. The capsules mature in autumn; they are not as frequent as one would expect from the abundance of the plants.

Hylocomium rugosum (Ehrh.) De Not., Wavy Hypnum. When well developed this is one of the most striking of our mosses; the stems reach a length of four inches or more, and with the leaves are as thick as a lead pencil. The branching may be sparse and irregular or frequent and pinnate. The rather dense mats are usually bright glossy yellowish-green. The leaves are ⅛ inch or more in length, strongly falcate-secund, strongly wrinkled or undulate crosswise, with a single costa running ⅔ the length of the leaf. Small depauperate specimens may not be recognized at first sight, but the peculiarities of the leaves are well marked. It never fruits in this part of the world. Its favorite habitat is on bluffs.

Hylocomium triquetrum (L.) B. & S., the Shaggy Moss, is common on shaded banks that are neither extremely wet nor very dry. Its branches usually come out irregularly as illustrated in the figure and its leaves stand straight out from the stem, giving it its characteristic ragged appearance. Sometimes in moist mountain woods it branches regularly and grows to a height, or rather length, of five or six inches, so that one is with difficulty persuaded that it is the familiar moss of every day acquaintance. The stems are very stout and stiff but elastic, or "springy." Because of this elasticity this moss is sometimes used for packing china and other brittle objects. Although the Shaggy Moss is common, its capsules are rather infrequent. They mature in winter or early spring; when dry they are often regularly furrowed with deep wide furrows. The leaves have two slender parallel nerves reaching about ¾ the length of the leaf. (Figs. 85 and 86.)

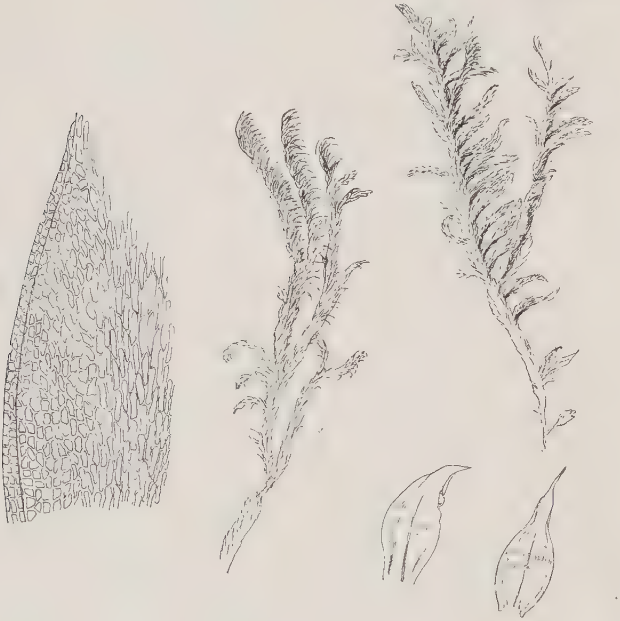


FIGURE 84.

Hylocomium rugosum. Plant natural size; leaves, × 5, and leaf cells.

CAMPYLIUM CHRYSOPHYLLUM (Bryhn), the Spreading-leaved Hypnum, is a moss common on soil, stones, bases of trees, etc., in shaded swampy places, and on wet cliffs. It is highly variable,

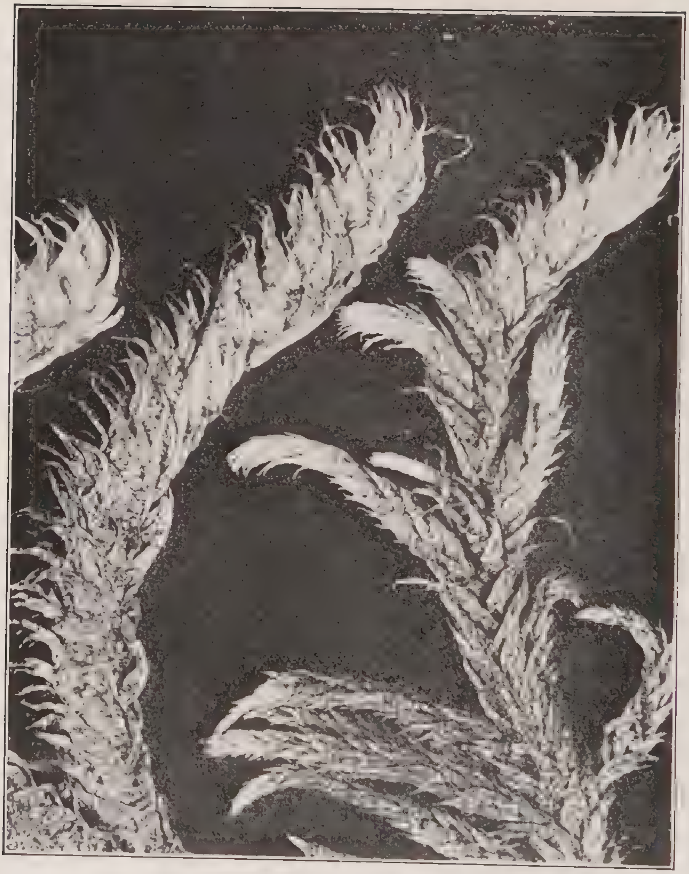


Plate LXI. *Hylocomium rugosum*, × 5.

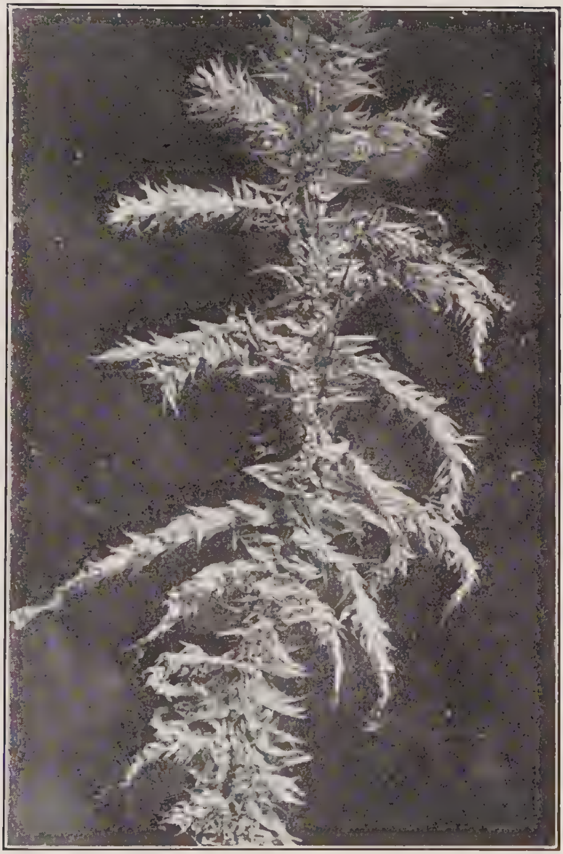


FIGURE 85.
Hylocomium triquetrum, × 5.

but always has the leaves spreading at nearly right angles whether wet or dry. The plants are usually slender and creeping; the leaves are costate and of the shape shown in the figure. The capsules are not wrinkled and mature in late June. (Pl. LXXII.)

PLAGIOTHECIUM STRIATELLUM (Brid.) Lindb., the Ribbed Hypnum, is another moss common in swamps and damp places, especially at the roots of trees and on peaty hummocks. The leaves are spreading as in the preceding, but the plants are much less creeping, the costa is absent, the capsule is plainly wrinkled when dry much as in *Hypnum curvifolium* (See Fig. 78), and at the basal angles are a number of inflated hyaline cells as shown in the plate. The spores mature in early May in the vicinity of New York City, where both this and the preceding species are common. The wrinkled capsules, spreading ecostate leaves, and early season of maturing spores make this an easy species to identify.

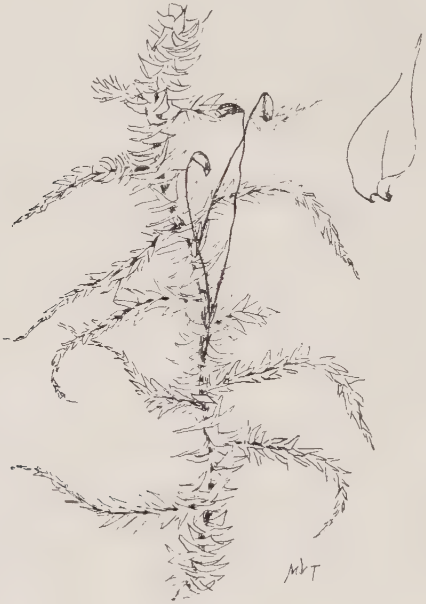


FIGURE 86.
Hylocomium triquetrum, × 1.

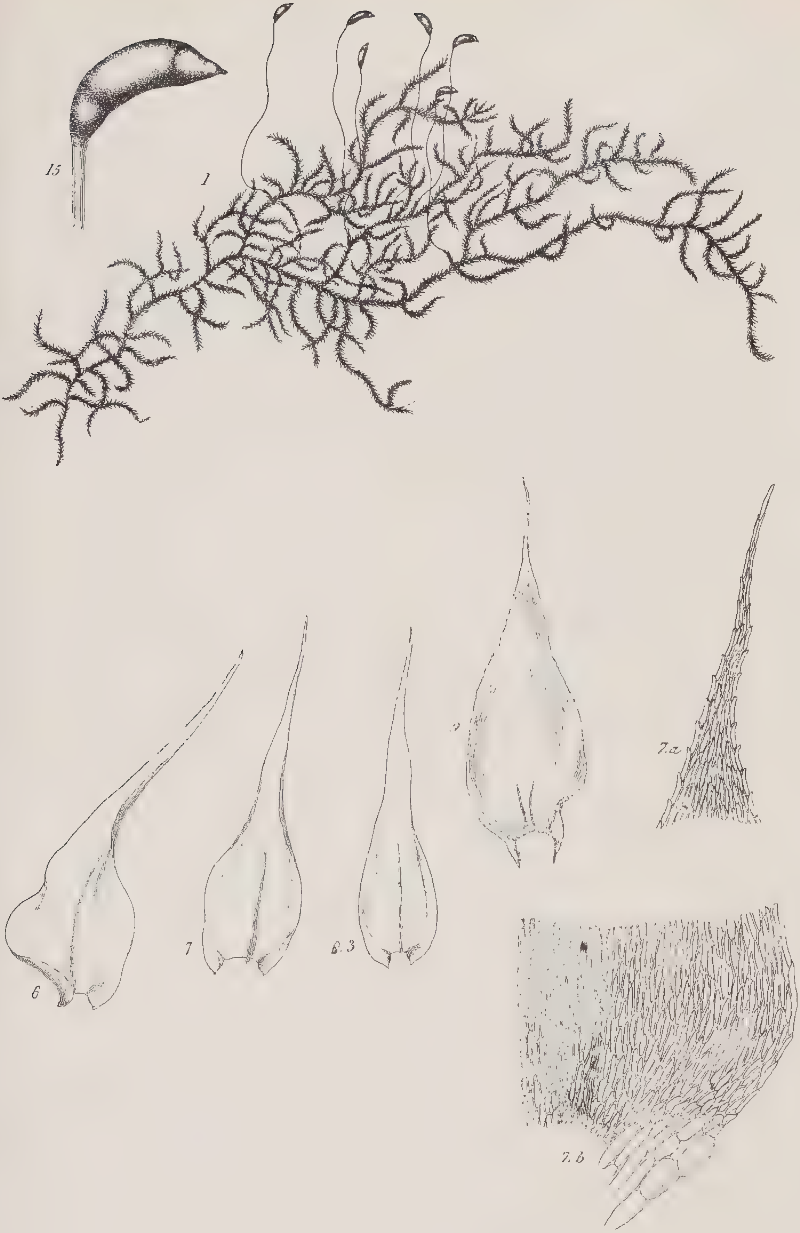


PLATE LXII.

1. Plant of *Campylium chrysophyllum* natural size. 15. Capsule of the same. 6, 7, and B3. Leaves of the same. 9, 7a, and 7b. Leaf, leaf apex and base of *Plagiothecium striatellum* (From Bry. Eur.).

The Hooked Mosses.

Growing on stones, earth, and decayed wood in shaded swamps, edges of brooks, and shores of lakes and streams, will be found another type of Hypnum with strongly secund and hooked leaves. These mosses belong to the subgenus Harpidium of Sullivant but now usually considered as a separate genus *Drepanocladus*. As a rule the Hooked Mosses are much larger than the true Hypnums and are seldom or never regularly pinnate. The leaves at the end of the branches are specially noticeable for their hook-like appearance. Mounted and examined with a high-power lens, the leaves will be seen to have a well-developed midrib, which at once distinguishes them from those of the true Hypnums.

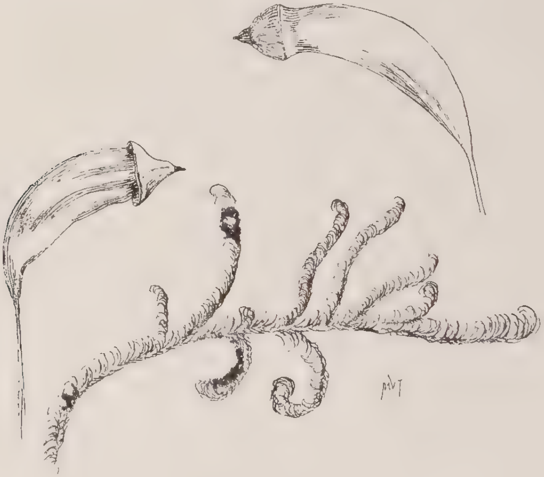


FIGURE 87.

Hypnum uncinatum, × 1; capsules, × 10.

The species of this subgenus are, perhaps, the most puzzling of any of the Hypnum Family and it is entirely useless to endeavor to enable anybody to distinguish the species without the use of a compound microscope.

HYPNUM UNCINATUM Hedw., the species figured, is the most common member of the subgenus. It is most frequently found on damp stones, more rarely on soil. The capsules are usually produced freely, maturing in autumn.

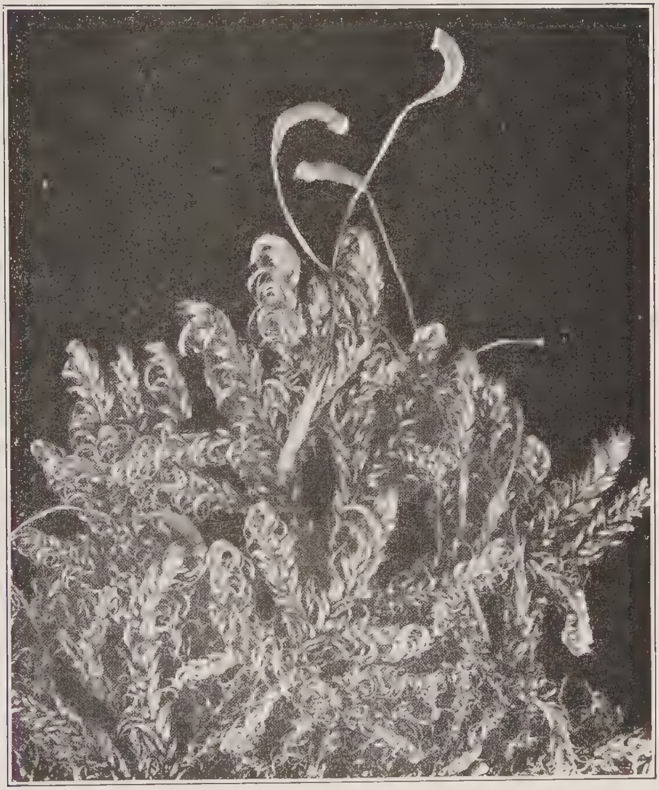


FIGURE 88.
Hypnum uncinatum, × 5.

AMBLYSTÈGIUM.

Most Amblystegiums are very slender creeping mosses with capsules which are often disproportionately large and which usually take the peculiar position shown in Fig. 90, 31 and 32, when dry. This peculiar shrinking is not always present; it is lacking in *A.*

adnatum which has been treated in connection with *Hypnum reptile.* Another species, *A. irriguum,* is treated in connection with the Water-loving Hypnums. The species as a rule are hard to determine without a compound microscope and only one other is included here, although we have a much larger number of common species.

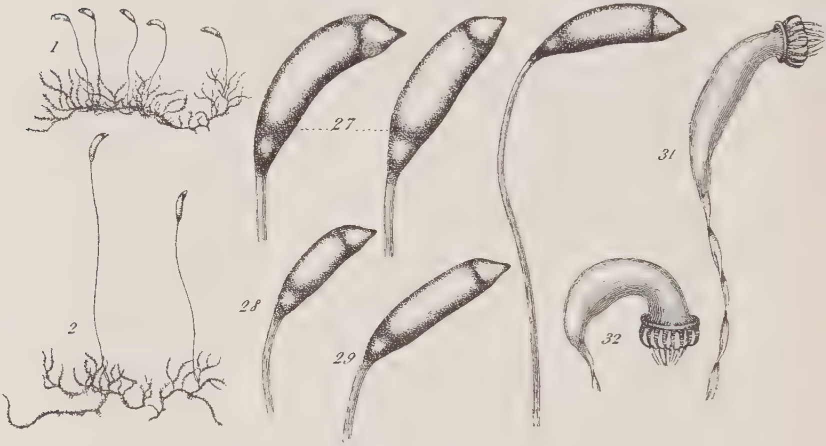


FIGURE 89.

Plants of *Amblystegium serpens,* natural size and capsules much enlarged.

A. SERPENS (L.) B. & S., the Creeping Hypnum, is common on soil and moist rotten wood in shaded places. As will be seen from the figures of the plants, the leaves are almost too small to handle readily with forceps, but when mounted a well developed costa can be made out. The capsules are large and conspicuous. We have numerous other species which can not readily be distinguished from this.

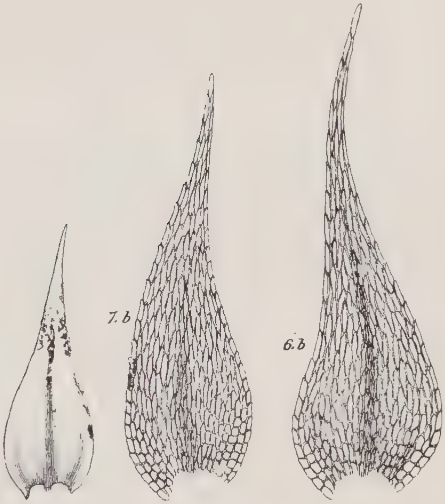


FIGURE 90.
Leaves of *Amblystegium serpens*, highly magnified.

The Water-loving Hypnums.

There are several species belonging to the Hypnum Family that grow on the stones in the bed of brooks, particularly in mountain regions. They do not belong to one genus, but their similarity of habitat, often combined with similarity in appearance, makes it easier to study them together.

Of the Water-loving Hypnums treated here four, *H. dilatatum*, *H. ochraceum*, *Rhynchostegium rusciforme*, and *Amblystegium irriguum*, grow on stones in brooks and are constantly submerged except at the very lowest water. *Brachythecium plumosum* is found on stones and soil wet by spray or submerged at high water, also in swampy places. *Brachythecium rivulare* may grow either in the water or alongside the stream or in very wet swamps. With the exception of *H. ochraceum* the four mosses growing in the water are almost black except the young growing tips of stems and branches.

EURHYNCHIUM RUSCIFORME (Neck.) B. & S., the Beaked Water Moss, is the coarsest, with broadly ovate costate leaves and strongly beaked capsules, which latter mature in September. They are light-colored and frequently produced in large quantities and present a very pretty appearance indeed against the dark background of the leaves.

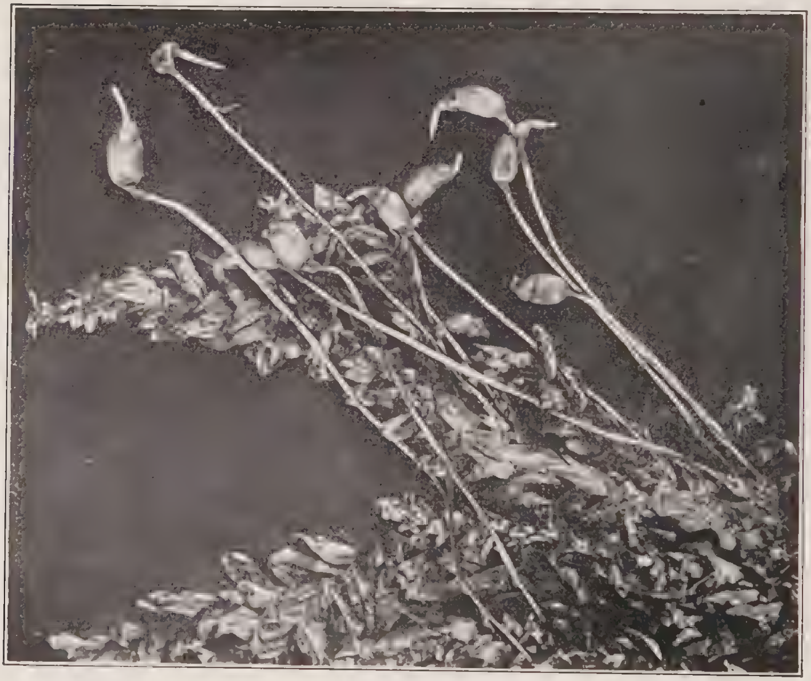


FIGURE 91.
Eurhynchium rusciforme, × 5. From herbarium specimens.

H. DILATATUM Wils., the Round-leaved Hypnum, belongs to the subgenus *Hygrohypnum*. Its leaves are suborbicular and ecostate. The capsules are not beaked. They mature in July according to Limpricht, but in autumn according to my observations. The Round-leaved Hypnum is frequent in mountain

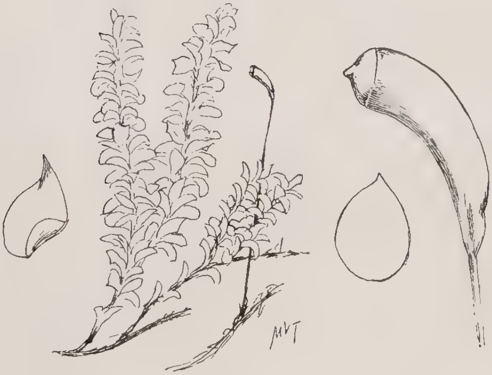


FIGURE 92.
Hypnum dilatatum, × 3; leaves and capsule, × 10.

streams, but has formerly been referred to another closely related species (*H. molle* Dicks.), a much rarer moss with ovate-elliptical leaves.

There are several other species of *Hygrohypnum* that may be found in water. One of these (*H. ochraceum* Turn.) may be recognized by its yellowish or ochre-green color and strongly secund leaves narrowly obtuse at apex and having the costa short and double, or single and half the length of the leaf or more.

AMBLYSTEGIUM IRRIGUUM (Hook. & Wils.) B. & S. is a small moss very much smaller than any of the other Water-loving Hypnums. The leaves are strongly costate to the apex. The peculiarity of this moss is its harsh gritty feeling, which remains after being thoroughly washed. This is, perhaps, the blackest of the four submerged species. The capsules are in good condition in summer; when dry and empty they assume the characteristic Amblystegium pose shown in *A. serpens*, though they are smaller than in that species.

BRACHYTHÈCIUM.

The Brachytheciums, as previously stated (p. 170), are distinguished by their short thick unsymmetric cernuous capsules, and leaves with a well-developed midrib. There are at least two species of Brachythecium that should be classed among the water-loving members of the Hypnum Family, although they are not so thoroughly aquatic as the two species just described.

B. RIVULARE B. & S., the Rivulet Brachythecium, loves best the wet gravelly soil at the edges of cool swift brooks. Frequently it will entirely cover the gravelly bottom of a mountain stream that is nearly dry during the summer. It is submerged at times of high water and never grows in places that become entirely dry; occasionally it will grow submerged, but even then it is attached to the gravel at the bottom of the stream and not to the stones as in the case of the two preceding species. When growing submerged the stems of the Rivulet Brachythecium become greatly elongated, slender and sparingly branched, with few and distant leaves. It is always much lighter-colored than either the Beaked Water Moss or the Round-leaved Hypnum; the leaves are rather smaller, ovate and obtusely acute. The branch leaves are usually much smaller than the stem leaves, and are slenderly pointed. If the stem leaves be carefully removed and mounted the alar cells will be seen to be quite appreciably larger than the others, although not so markedly so as in the Common Hypnum. The stems are often tall and

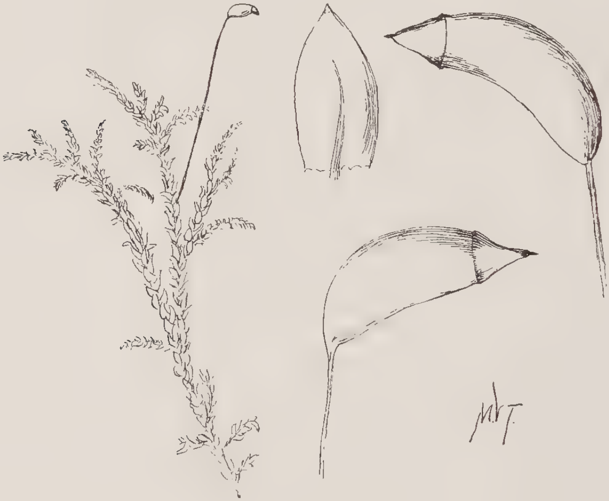
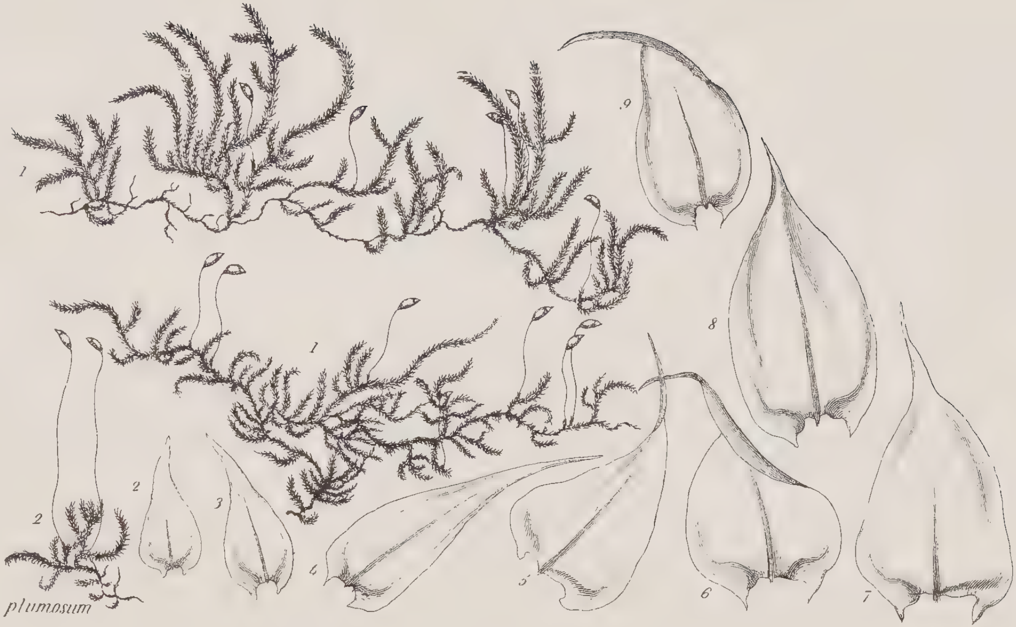


FIGURE 93.
Brachythecium rivulare, × 1; leaf and capsules, × 10.



1
1
2
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9
plumosum

PLATE LXIII. *Brachythecium plumosum* (From Bry. Eur.).
1. Plants natural size. 2, 3, and 4. Branch leaves. 5–9. Stem leaves.

stout, with a shrub-like habit. The capsules are not beaked and mature in autumn. If the seta be examined with a high power lens it will be seen to be covered with fine papillae throughout.

B. PLUMOSUM (Sw.) B. & S. grows on rocks in the bed of brooks, but is not submerged except at high water. The difference in habit alone is sufficient to distinguish it from *B. rivulare;* it is much smaller, darker green, more closely applied to the substratum, nearly prostrate, with acuminate stem leaves. The seta is papillose in the upper portion only. (Pl. LXIII.)

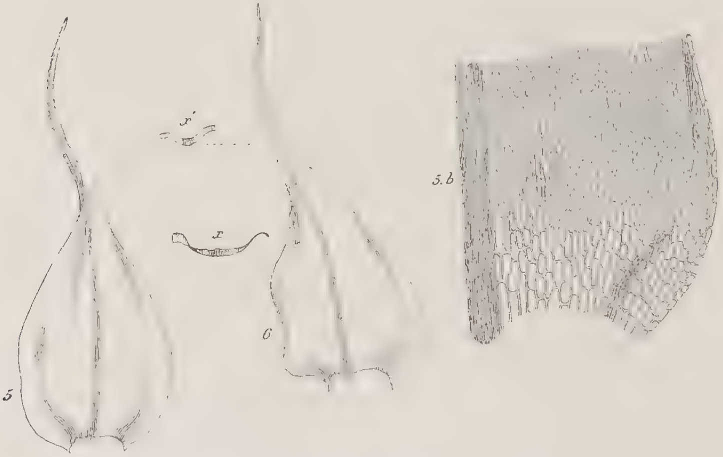

FIGURE 94.

Leaves and leaf base of *Brachythecium populeum* (From Bry. Eur.).

B. POPULEUM (Hedw.) B. & S. is a much more slender species growing on boulders, often near streams, but never on stones regularly submerged at high water. In this species the midrib runs to the very apex of the leaf, and the seta is papillose in the upper part only.

B. SALEBROSUM (Hoffm.) B. & S. much resembles *B. oxycladon* and *Hypnum Haldanianum* in its leafy parts but it has short curved and drooping capsules as shown in the photograph. The capsules ripen in autumn and early winter.

B. VELUTINUM (L.) B. & S. is a small and inconspicuous species found most frequently on soil at the base of trees but also on soil and stones in shaded places, rather drier than is inhabited by most of this genus. This species will not be recognized readily except when fruiting as the plants are small for the genus and the leaves are plainly secund as shown in the cut. The setae are strongly papillose. The plants figured were collected in April. (Fig. 96.)

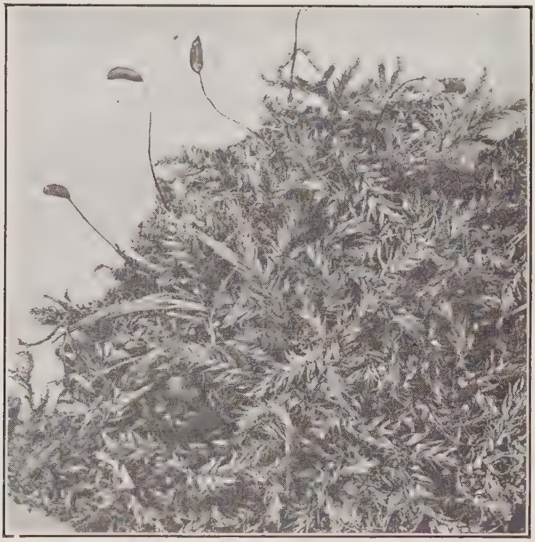

FIGURE 95.
Brachythecium salebrosum, × 4.

Two other species of Brachythecium are treated elsewhere (pp. 184 and 211).

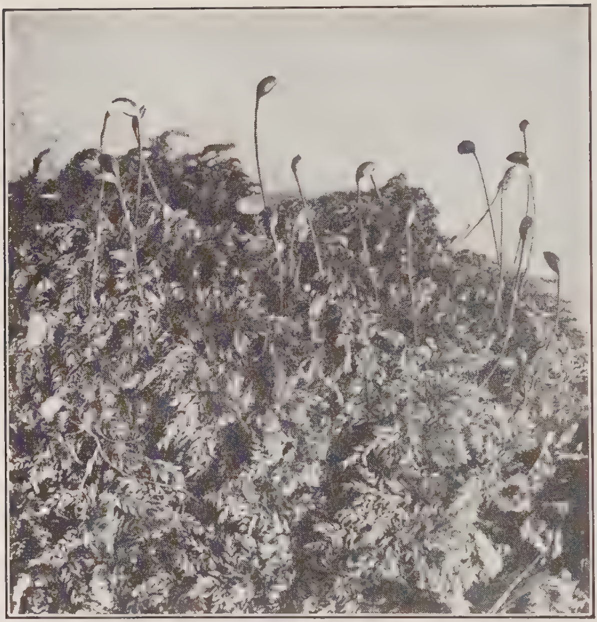

FIGURE 96.
Brachythecium velutinum, × 5.

The Beaked Mosses.

As has been previously stated, the Beaked Mosses (*Eurhynchium*, *Rhynchostegium*, and *Cirriphyllum*) are very closely allied to *Brachythecium*, differing mainly in the long-beaked operculum. One of these, the Beaked Water Moss, has already been described on page 196.

There are several species of Beaked Mosses that belong in the genus *Eurhynchium* that are fairly common, but it is doubtful if they can be accurately determined without the aid of the compound microscope.

EURHYNCHIUM HIANS (Hedw.) J. & S., the Light Beaked Moss, is very common on sandy soil in the lowlands. It is abundant in the public parks of Brooklyn, but rarely fruits there. It prefers damp places, not wet. The leaves spread so that the branches appear flattened in a horizontal plane. When fresh, the color is a peculiar shining light yellow-green. The branch leaves are usually bluntly acute. The capsules are produced sparingly, maturing in October.

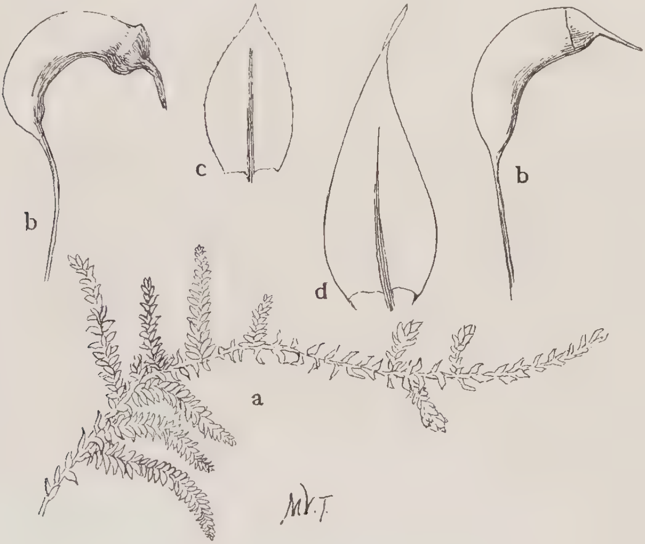

FIGURE 97.

a. ***Eurhynchium hians***, × 2. b, b. Capsules, × 10. c. Leaf, × 20. d. Leaf of *Rhynchostegium serrulatum*, × 10.

EURHYNCHIUM STRIGOSUM ROBUSTUM Roell., Common Beaked Moss. This species is common on the ground, roots of trees and decaying wood in cool woods, particularly on the sides of ravines. The plants are about the size of the preceding, but form closer mats, are a darker green, and are not flattened. The seta is smooth, while in *E. hians* it is very rough. One should not attempt to identify any of the Beaked Mosses for the first time unless the lids are on some of the capsules, for it can not be done with certainty.

EURHYNCHIUM SERRULATUM (Hedw.) Kindb., the Dark Beaked Moss, is found in a similar habitat, but has a more southerly and coastwise range, and is more likely to be found near the base of trees. It is also flattened, but is a rich green in color and the leaves are much longer and more slenderly acuminate, as shown in the figure. The seta is smooth.

Cirriphyllum Boscii. (Schwaegr.) Grout, the Spoon-leaved Moss, is one of the Beaked Mosses that is easy to recognize when in its normal condition. It grows in fields among the grass and on the ground in woods. Its leaves are very concave, being shaped much like the bowl of a spoon with a long twisted point added. The leaves are very regularly imbricated, making the branches

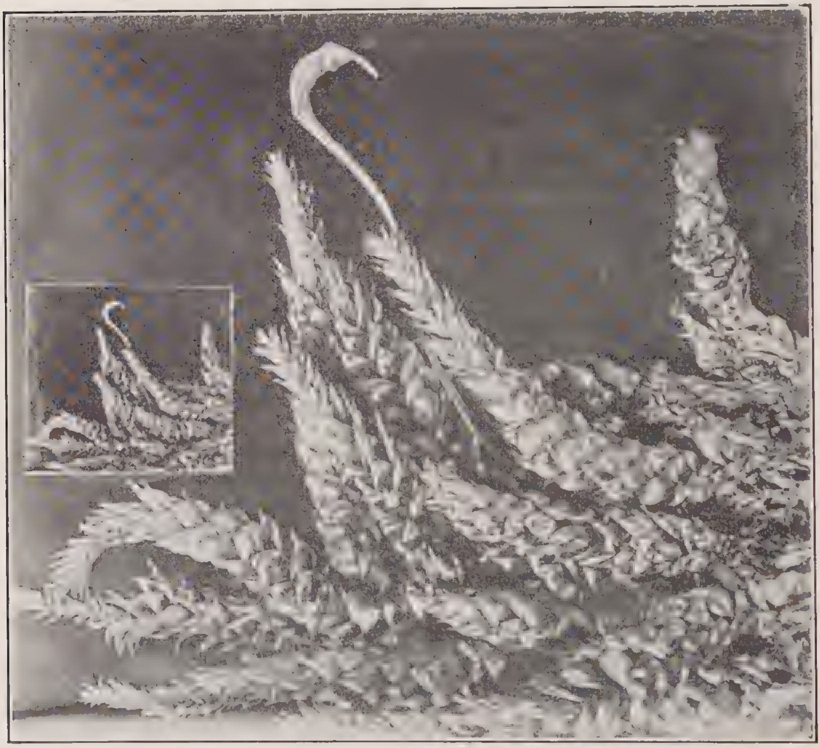

Figure 98.
Cirriphyllum Boscii, × 3.

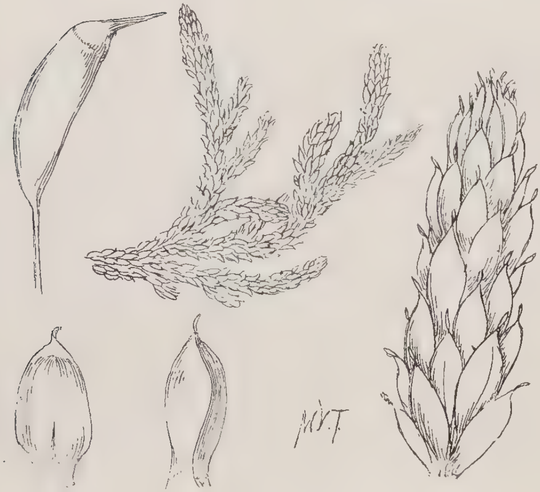

FIGURE 99.
Cirriphyllum Boscii, × 4/3; branch, × 5; leaves and capsule, × 10.

turgid and very markedly julaceous, so that they look like little glossy yellow-green catkins. Although it gets as far north as southern Vermont, it is much more abundant southwards. It fruits sparingly, the capsules maturing in autumn.

PLAGIOTHÈCIUM.

The stems and branches of the Plagiotheciums grow close to that upon which the plant grows (substratum) and the leaves are apparently in two rows, giving the plants a flattened appearance like that of the Dark and the Light Beaked Mosses. They are readily separated from the Beaked Mosses by the fact that the Plagiotheciums have leaves without a midrib or else with a very short and double midrib. The capsules are also an aid, as they are long and slender like those of Hypnum proper. The species are numerous and difficult to determine.

There are two species everywhere present that may perhaps be recognized with the aid of a brief description and the accom-

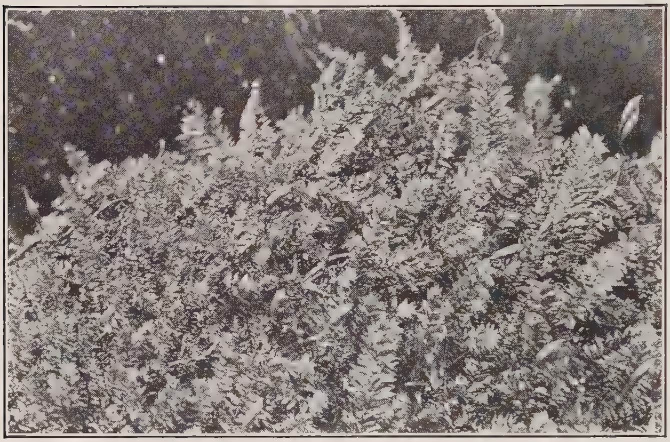

FIGURE 100.
Plagiothecium denticulatum, × 2.

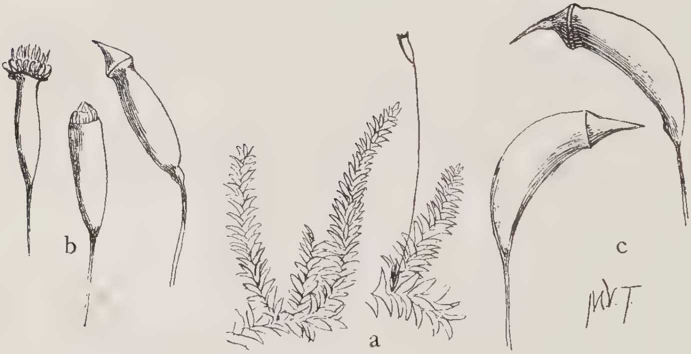

FIGURE 101.
a. *Plagiothecium denticulatum,* × 2. b. Three capsules of the same, × 10. c. Capsules of *P. sylvaticum,* × 10.

panying cuts. Both these species grow on humus in damp woods and shaded places; they grow at the base of trees and about rocks where there is a slight layer of humus for their nutrition.

P. DENTICULATUM (L.) B. & S., the Slender Plagiothecium, is more slender in habit and has nearly symmetrical suberect capsules with the lid not beaked.

P. SYLVATICUM (Huds.) B. & S., the Woodsy Plagiothecium, is generally a much coarser plant with larger, curved and cernuous capsules having a long-beaked lid. The capsules of both species mature in summer.

PYLAÌSIA.

Pylaisia affects the habitat of the Grimmia Family in that it grows on the bark of living trees. It is readily distinguished from the members of that family by being pleurocarpous, by the long-exserted capsules, by the lighter green color, and by having the branches somewhat hooked at the end when dry. Old apple trees in rather dense orchards are a favorite habitat.

P. SCHIMPERI R. & C., the Common Pýlaisia. (*P. intricata* of most authors). It is also common on trees in the open woods and can be found on the shade trees of almost any of the smaller New England towns, but does not seem to thrive near the large cities. The plants grow closely interwoven and present the appearance represented in the figure only when disentangled. The erect subcylindric capsules mature in autumn.

Pylaisia seems to be favored by most botanists in spite of technical objections, so *Pylaisiella* is dropped in this edition.

ÉNTODON.*

The Entodons have erect symmetric capsules, ecostate and very concave leaves and a beautiful glossy yellow-green color that enables one to recognize them without much trouble. The majority of the species are flattened, but have the appearance of being pressed flat instead of having the leaves apparently two-ranked as in Plagiothecium.

E. SEDUCTRIX (Hedw.) C. Muell., the Round-stemmed Entodon, is probably the most common species in the southern portion of our range. The stems and branches are round and julaceous

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* *Entodon* C. Muell = *Cylindrothecium* B. & S.

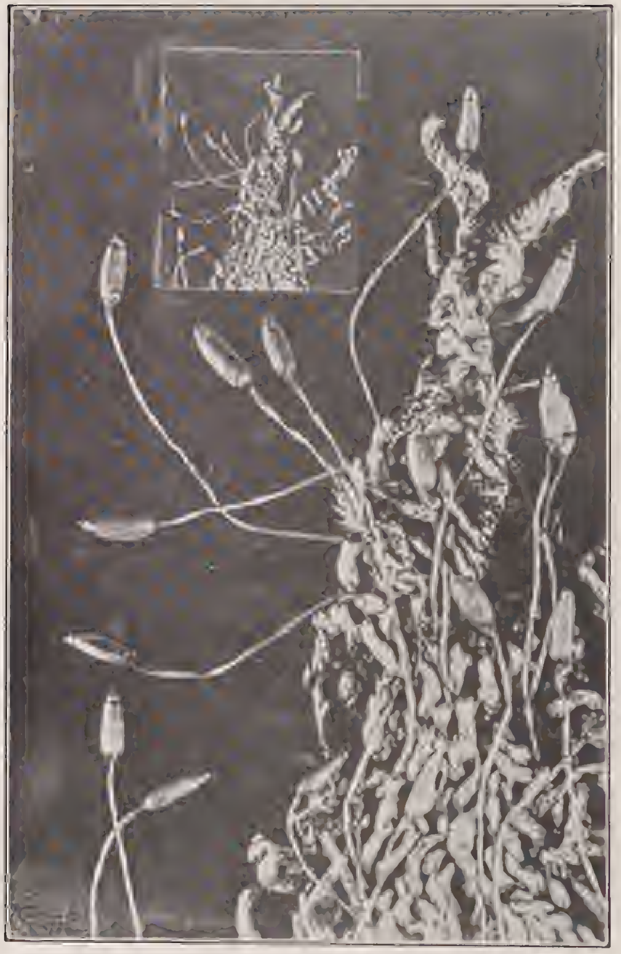

PLATE LXIV. *Pylaisia Schimperi*, × 5.

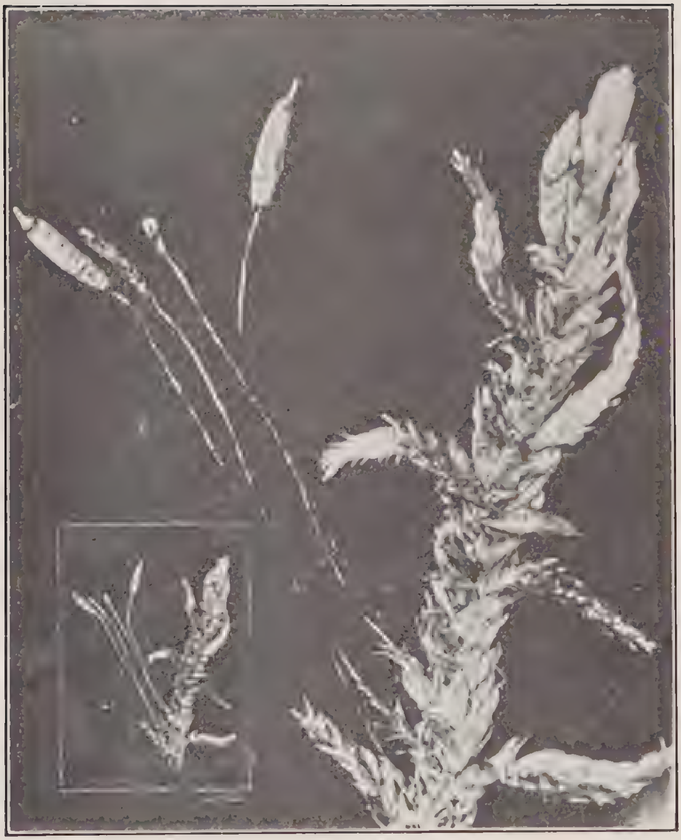

PLATE LXV. *Entodon cladorrhizans*, × 4.

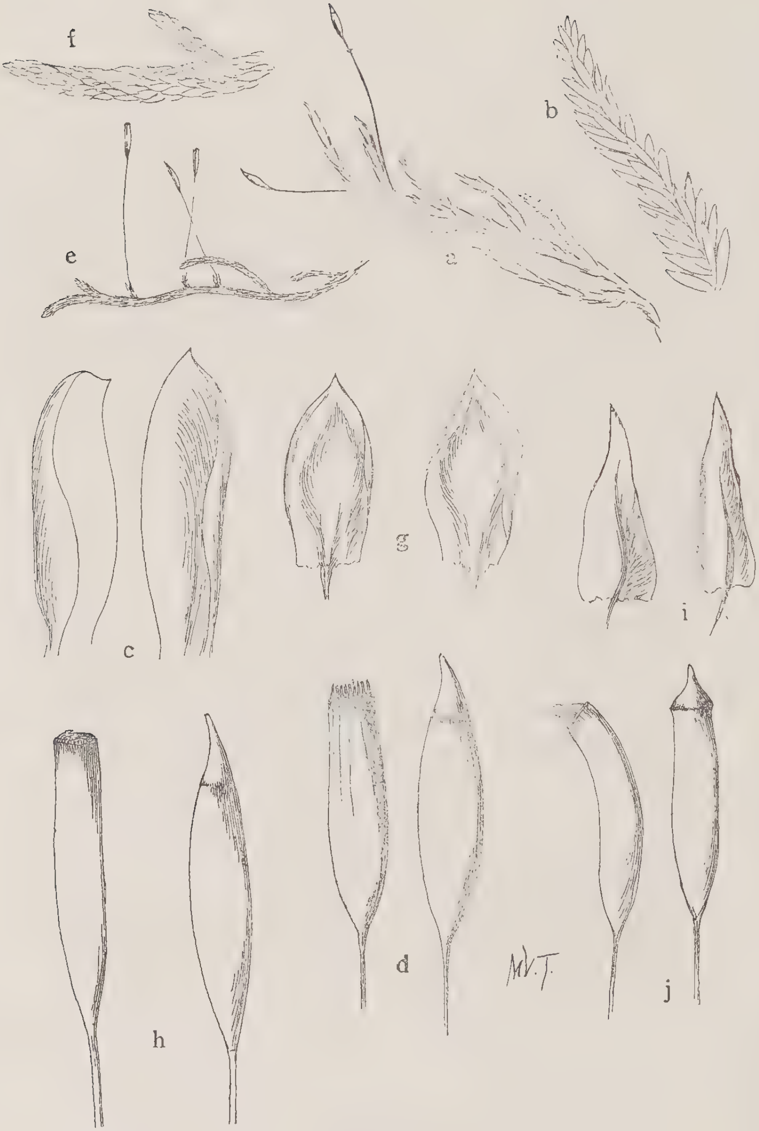
f
b
e
a
c
g
i
h
d
M.V.T.
j

PLATE LXVI.
Explanation on next page.

with closely imbricated leaves. It grows on rotten wood, soil, moist rocks, bark of trees, etc.

E. CLADORRHIZANS (Hedw.) C. Muell., the Flat-stemmed Entodon, is nearly always found on decayed wood, rarely on soil rich in humus. Its strongly flattened stem and branches easily distinguish it from the Round-stemmed Entodon. This character, together with the peculiar color characteristic of the genus, will differentiate it from species belonging to other genera. There are a number of other American species of Entodon that resemble the Flat-stemmed Entodon, but they are rare and not likely to be met with. The leaves of both species are very concave, but those of the Flat-stemmed Entodon are larger. Both species mature their capsules in autumn or early winter. (Pl. LXV.)

B. ACUMINATUM (Hedw.) Kindb., the Erect Brachythecium, is often mistaken for the Round-stemmed Entodon. It has a similar habitat and very nearly the same range. It also has julaceous light-green branches and erect symmetric capsules. A careful examination of the leaves will enable one to decide at once to which of the two any given specimen belongs. The leaves of the Brachythecium are somewhat smaller, scarcely concave, ovate-lanceolate, gradually acuminate, and strongly costate. The Erect Brachythecium is an anomaly in the genus and it and its allies should probably be placed in a separate genus. It is not related to Entodon, but is treated in connection with it because of its similarity in appearance. Its capsules are occasionally somewhat curved. They mature in autumn.

CLIMÀCIUM. The Tree Mosses.

The Tree Mosses are perhaps the largest of the pleurocarpous mosses. They are very markedly tree-like in habit and this, together with their size, has always brought them to the notice of those accustomed to country life. They are often mistaken for small forms of the Running Pine (*Lycopodium*). These mosses

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PLATE LXVI.

Entodon cladorrhizans, × 1. b. Branch, × 5. c. Leaves, × 20. d. Capsules, × 10. e. *E. seductrix*, × 1. f. Branch, × 5. g. Leaves, × 20. h. Capsules, × 10. i. Leaves of *Brachythecium acuminatum*, × 20. j. Capsules of the same, × 10.

are common in moist or wet soil, particularly in wooded swamps, where their favorite habitat is around the bases of stumps, trees or other similar elevations. They are also found in moist grassy places, but rarely fruit in the latter habitat, and infrequently in the former. The erect tree-like shoots grow from stolons that are partially or wholly underground. These continue to grow horizontally, producing new shoots each year.

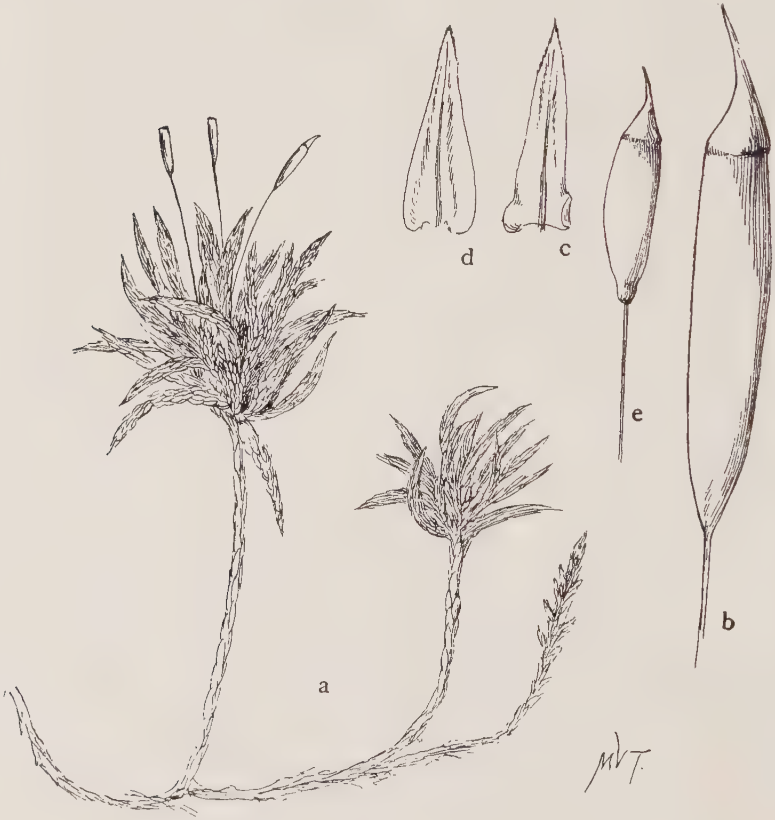

FIGURE 102.

a. *Climacium americanum*, × 1. b. Capsule, × 10. c. Branch leaf, × 10. d. Branch leaf of *C. dendroides*, × 10. e. Capsule of the same, × 10.

C. DENDROIDES (L.) Web. & Mohr., the European Tree Moss, and

C. AMERICANUM Brid., the American Tree Moss. The leaves of the American Tree Moss are usually much more closely appressed when dry and are much more conspicuously auricled; its capsules are nearly twice as long as those of the European Tree Moss. Both species mature their capsules in autumn. The European Tree Moss is a native of America as well as of Europe, but it was first described from the Old World. It is more common northwards, while the American Tree Moss is more common southwards. Both species are common in New England.

C. KINDBERGII (R. & C.) Grout, a third form of the Tree Mosses, is common in swamps in the southern portion of our range. It grows close to the water and often down into it. It is prostrate creeping, and rarely, if ever, assumes a tree-like habit. It has previously been called a variety of the American Tree Moss (*C. Americanum* var. *Kindbergii* R. & C.), or Kindberg's Tree Moss. It is named after Dr. N. Conrad Kindberg, of Linkoeping, Sweden, who has determined Prof. Macoun's Canadian Mosses. This form is very abundant in the swamps of Long Island. It looks like a very coarse Hypnum with large erect symmetric capsules. It fruits freely, the capsules maturing in early autumn.

FAMILY 20. FABRONIACEAE.

ANACÁMPTODON Brid. The Knothole Moss, *A. splachnoides* (Froelich) Brid., is our only species and the only member of the family easily recognizable with a lens. Like all the other members of the family it is small and delicate with leaves regularly and closely imbricate when dry. It is most frequently found growing in knotholes in deciduous living trees (oak, apple, maple, etc.) where there is decayed wood that is soaked with moisture a good part of the time. It is well to look for it on sugar maple shade trees that have split so that water collects in the cleft and gradually seeps down the trunk. At Newfane, Vt., I have collected large masses of this moss in such situations. In knotholes the amount is usually small. Besides its habit and habitat, the most characteristic things about this species are its erect ovoid capsules, strongly contracted under the mouth when dry and empty, and with strongly reflexed peristome much like that of Orthotrichum. Spores ripe in June. Widely spread but extremely local and limited in quantity as a rule.

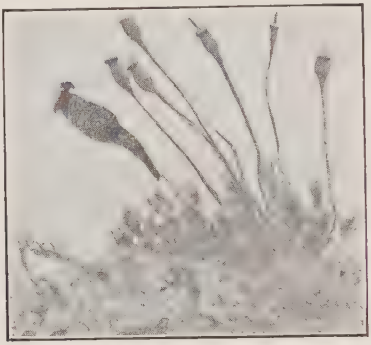

FIGURE 103.
Anacamptodon splachnoides, × 2; capsule, × 4.

FAMILY 21. LEUCODOTACEAE.

LEUCODON.

The various species of Leucodon grow almost exclusively on the bark of deciduous trees; very rarely are any found on dry rocks. The Leucodons are seemingly able to do without moisture for considerable periods, as they rarely or never grow at the base of trees, but at a height of five or six feet and above. The main stems are long, slender, branching, almost filiform, with minute leaves and abundant rhizoids. The branches are numerous, suberect, horizontal, or hanging downward and curved outward, usually julaceous and nearly simple. The leaves are concave, with margins recurved below, ecostate, entire, closely appressed when dry, spreading when moist. The calyptra is cucullate, often attached below the capsule by the clasping base. The capsules are exserted or emergent, erect and symmetrical; peristome apparently simple, teeth 16, bifid or occasionally trifid; inner peristome reduced to a narrow inconspicuous membrane.

We have three species, only one of which, *L. sciuroides*, is European. There is considerable difference of opinion as to what other genera of mosses should be grouped with Leucodon. More careful study of its development and structure is needed to determine whether its natural relationship is with the Neckeraceae or the Hypnaceae.

L. JULACEUS (Hedw.) Sulliv., the Southern Leucodon. This species is typically southern, extending north to Southern New England and corresponding latitudes of the Eastern United States. The secondary stems are typically shorter than in the other two species, the branches very round and julaceous when dry; the leaves closely appressed and imbricate, not at all secund, ovate-elliptical *abruptly short acuminate*, very concave and scarcely plicate. *Capsule long-exserted as in L. sciuroides;* teeth bifid at apex.

Easily recognized by its perfectly round stems and smaller, scarcely plicate, abruptly acuminate leaves.

L. SCIUROIDES (L.) Schwaegr. Forming tufts or mats of brownish green, lighter green at the tips of the secondary stems, which are terete and julaceous, more or less drooping and curved upwards

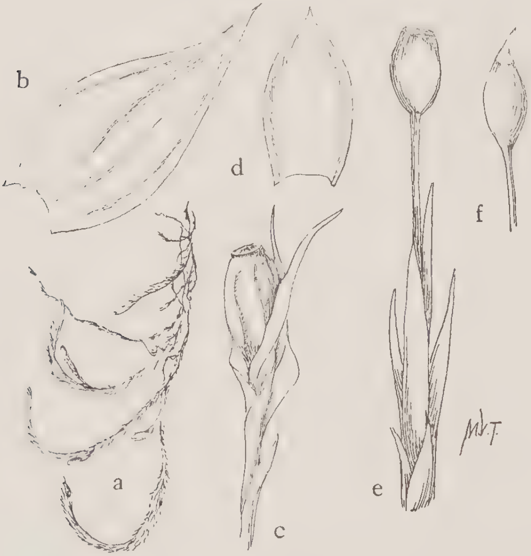

FIGURE 104.

a. Plant of *Leucodon brachypus*, × 1. b. Leaf of *Leucodon brachypus*, × 20. c. Sporophyte of *Leucodon brachypus*, × 10. d. Leaf of *Leucodon julaceus*, × 20. e. Sporophyte of *Leucodon julaceus*, × 10. f. Capsule of *Leucodon julaceus*, × 10.

at the ends, rarely 2 inches long, usually not over 1 inch, frequently producing such a great number of *flagelliform small-leaved branches as to cause the plant to appear deformed.* Leaves of branches slightly secund, ovate-lanceolate, somewhat decurrent, very long and slenderly acuminate, entire, plicate with several folds. Seta about 1/3 inch long; capsule exserted; teeth entire or split toward the base. Very rarely fruiting.

This is distinguished from *L. julaceus* by the different shape of its leaves. It fruits so rarely that it has to be differentiated from *L. brachypus*, which it closely resembles, by its leaf apices and flagelliform branches. The secondary stems are also much shorter than those of well-developed *L. brachypus.* Probably common in Northeastern United States and Eastern Canada, but not often collected or else confused with *L. brachypus.* Collectors should be on the lookout for it.

L. BRACHYPUS Brid., the Northern Leucodon. The branches average longer and larger than in the preceding species, less frequently branched. *Leaves more strongly secund*, plicate, but with fewer folds than in *L. sciuroides;* the apex is not nearly so slender and pointed as in *L. sciuroides.* The seta is 1/6 inch long, wrapped up in the perichaetial leaves, *which over-top the emergent* capsule; teeth bifid at apex. The spores mature in winter.

This has about the same range as the last, but extends farther south. Abundant and frequently fruiting in the mountain regions of Northeastern United States. It extends to Georgia along the mountains, but is rare south of New York.

FAMILY 22. NECKERACEAE. The Neckera Family.

NÉCKERA.

N. PENNATA (L.) Hedw.,* the Feathery Neckera, is found almost exclusively on the trunks of deciduous trees in cool moist woods, rarely on ledges or cliffs in similar situations. Neckera rarely grows near the base of a tree, nearly always growing well above that portion of the trunk occupied by Anomodon or Leskea, and extending upwards to a height of from twenty-five to fifty feet, according to the size of the trees and the density of the wood. Neckera is clearly characterized by its flattened branches, having wavy leaves, and its immersed capsules pendent from the lower side of the

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* The only species likely to be met with in our range.

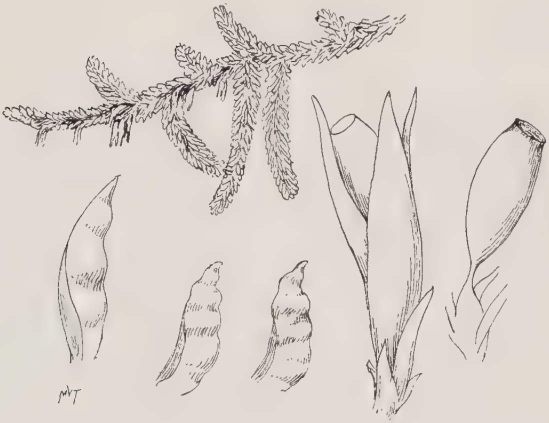

FIGURE 105.

Neckera pennata, × 1; leaves, × 10; capsules with and without perichaetial leaves, × 10.

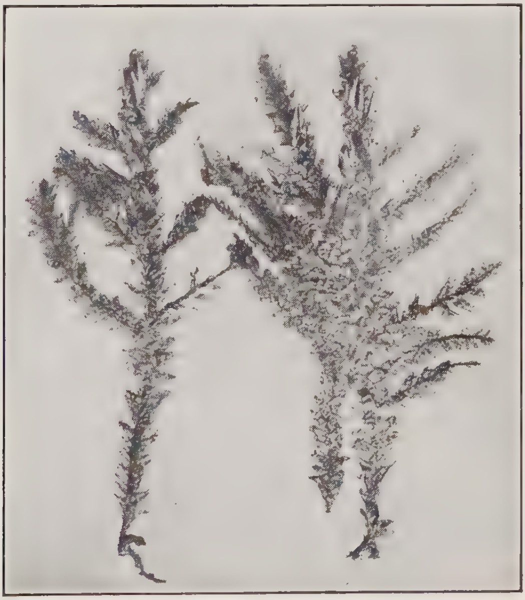

FIGURE 106.

Neckera pennata, × 2. Under side, showing fruit.

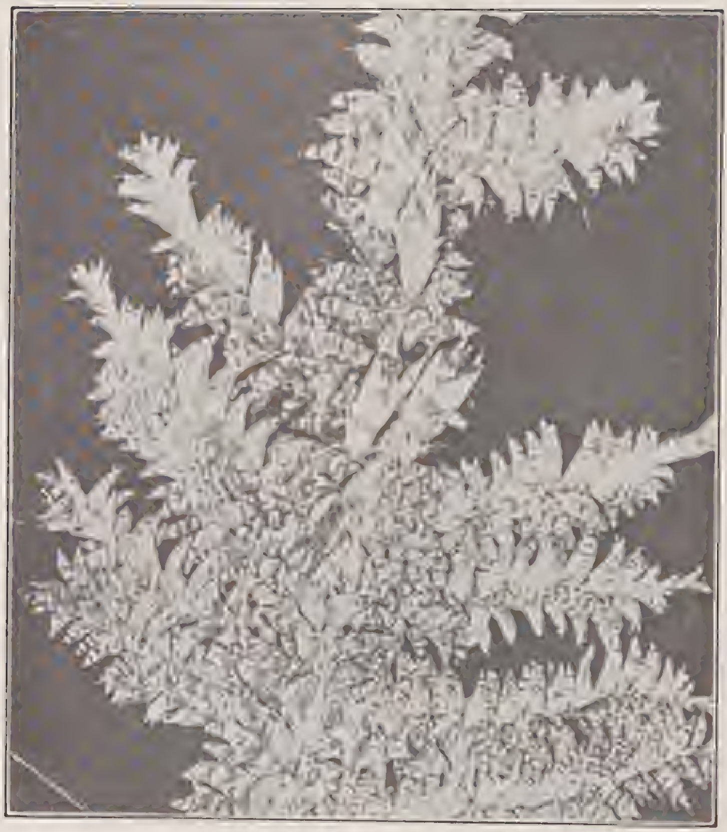

PLATE LXVII. *Neckera pennata*, × 5.

branches. The branches usually extend out from the tree trunk at an angle of from 45 to 75 degrees. The capsules are produced on the older portions of the plant, often in great numbers. They mature in summer.

HOMÀLIA.

Homalia trichomanoides (Schreb.) B. & S. var. Jamesii (Schimp.) Holz. Homalia is a very pretty moss, frequent on moist rocks in the mountains. I do not find it fruiting freely, but it is easily recognized by its flattened branches which look like a Fissidens or an hepatic. A close examination readily shows that it is neither, as the leaves are not double at base, and the midrib is well developed. A favorite place of Homalia is the underside of overhanging rocks at the base of ledges in cool moist ravines, where it often grows in single strands, the pendent and flattened branches producing a very pretty effect.

FAMILY 23. FONTINALACEAE. Water Moss Family.

Although mosses belonging to several other families are aquatic, the mosses of this family are most emphatically entitled to the name of Water Mosses. By some the scientific name is translated more exactly, and they are called the Fountain Mosses. The members of the family are either submerged all the time or attached to objects that are submerged at some seasons of the year. They are very dark and usually slender. The midrib is present in Dichelyma, but lacking in Fontinalis. The seta is usually short and wrapped up in the perichaetial leaves. The peristome is double, the inner forming a regular net through the meshes of which the spores gradually escape.

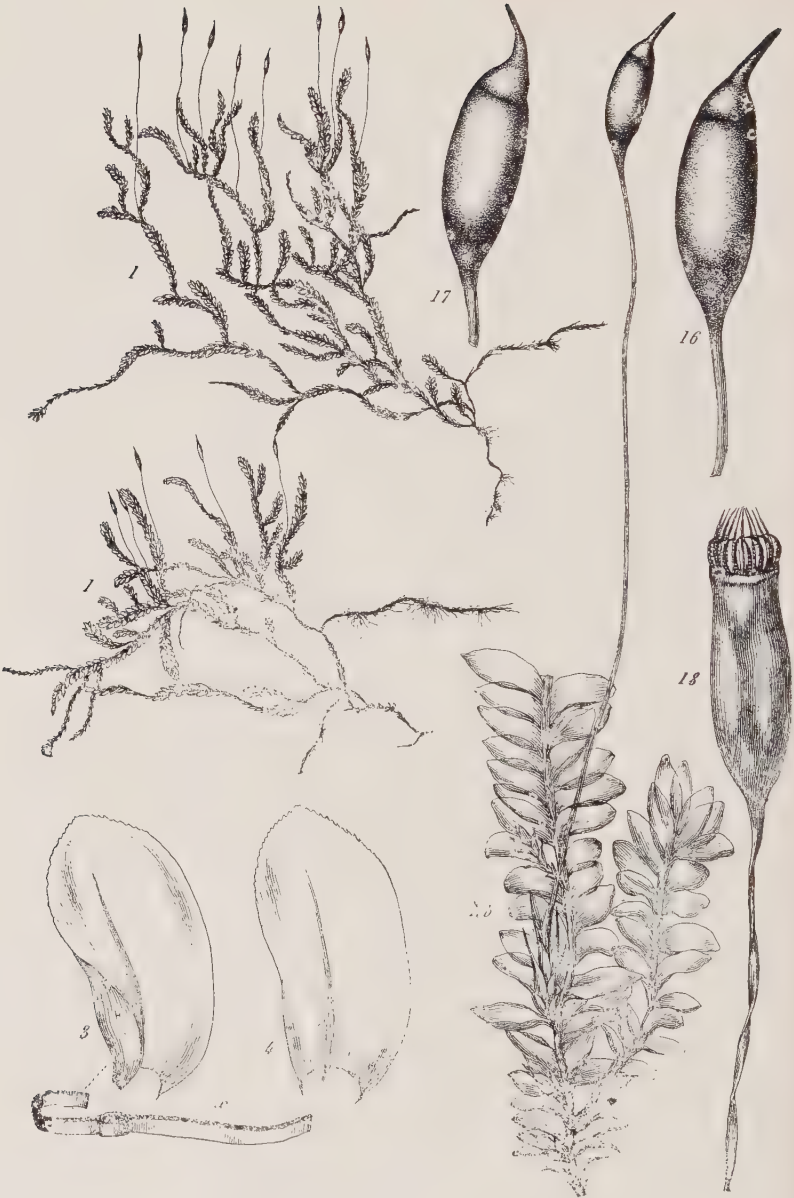
1
17
16
1
18
3
4

PLATE LXVIII. *Homalia trichomanoides* (From Bry. Eur.).
1. Plants natural size.

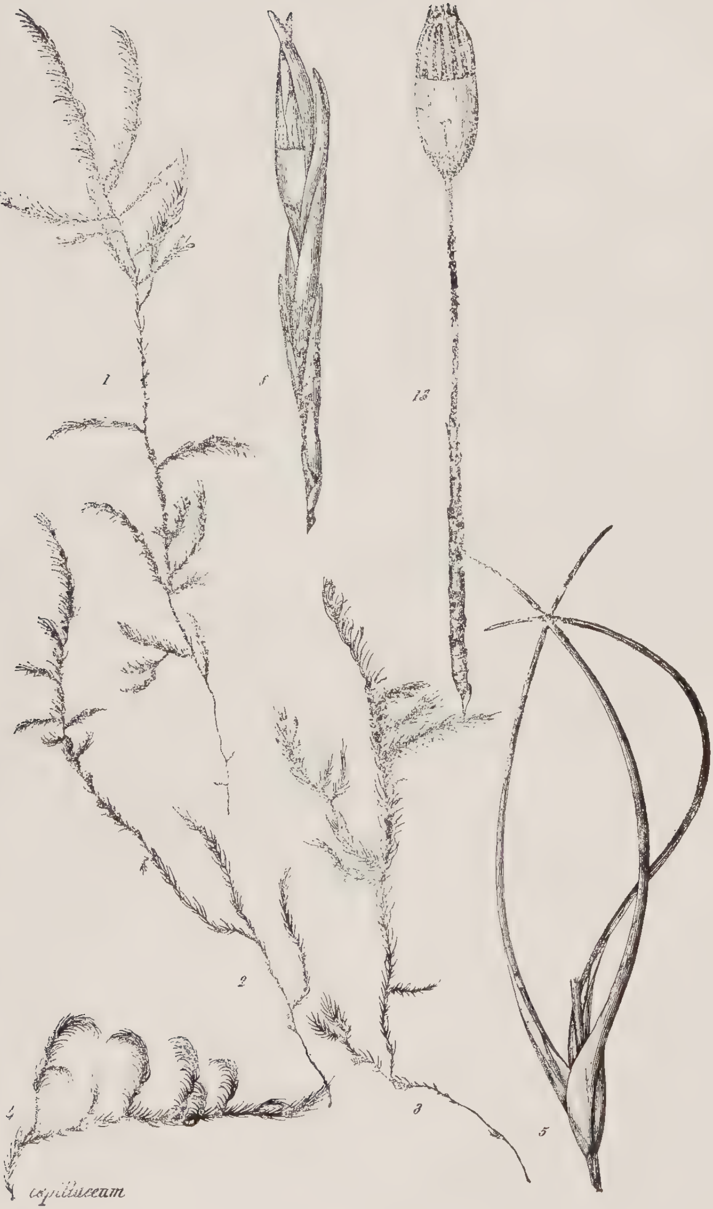
1
f
13
2
3
4
5
capillaceum

Plate LXIX. *Dichelyma capillaceum.* (From Bry. Eur.).
1–4. Plants natural size.

DICHÉLYMA.

D. CAPILLACEUM (Dill.) B. & S., is usually found attached to the stems of bushes that grow in swamps and on the edges of ponds. The stems of *Cephalanthus* are favorite attachments. The plants are not so long as in Fontinalis, and the branches are usually curved at the ends as shown in figure 4 of the plate. The leaves are very long and narrow and the costa stout and excurrent. The capsules are much like those in Fontinalis. The spores mature in late summer.

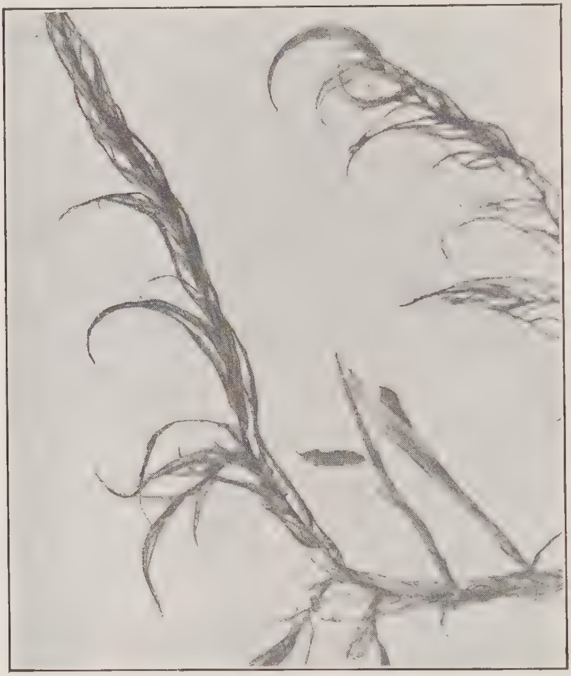

FIGURE 107.

Dichelyma capillaceum, × 5. Dry.

PLATE LXX.

a. *Fontinalis dalecarlica*, × ½. b. Branch, × 5 of *F. Novae-angliae*. c. Portion of plant bearing capsules, × 5. d. A short branch of *F. gigantea*.

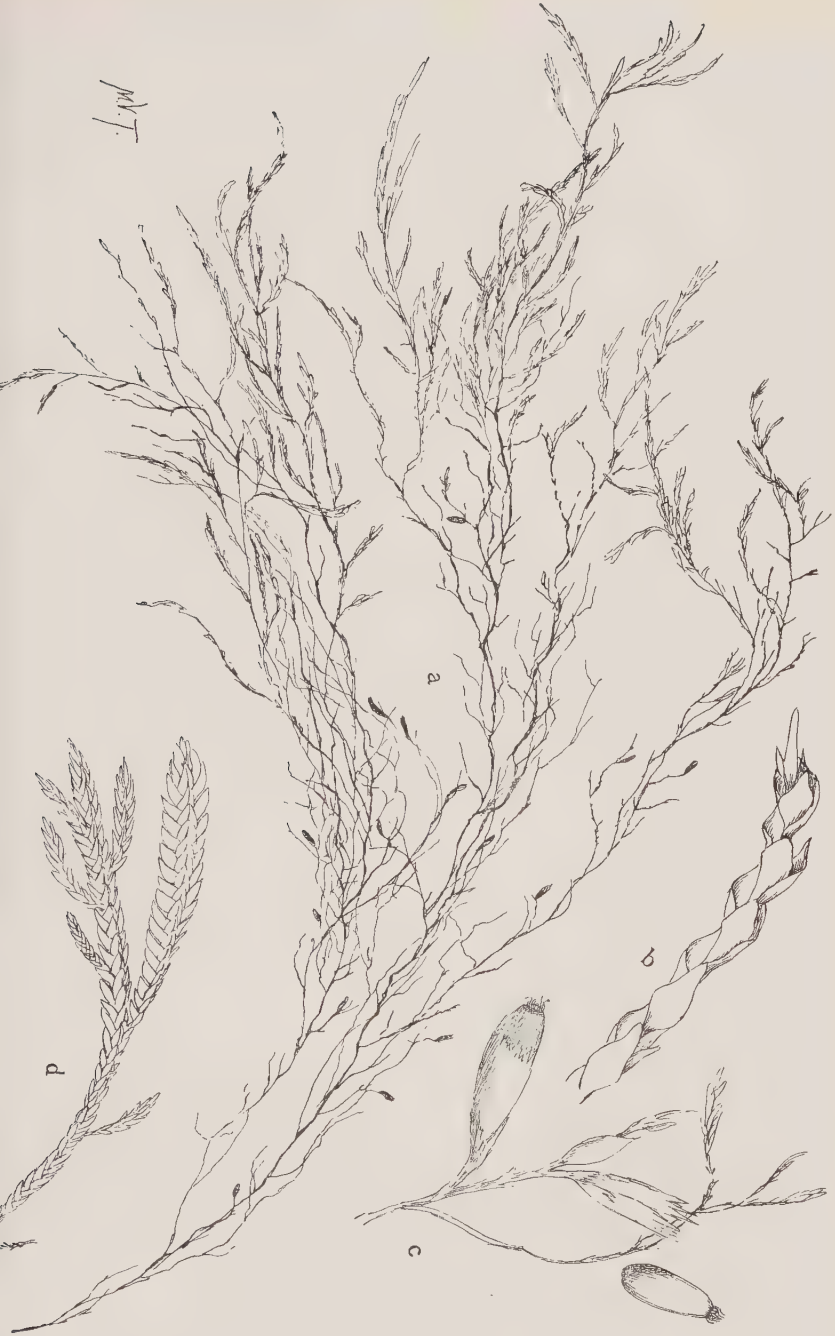

Plate LXX.
Explanation on preceding page.

FONTINÀLIS. The Water Mosses.

In the genus Fontinalis all the species are aquatic and submerged. Some grow attached to stones and sticks in swift brooks. Others are found attached to objects in ponds and sluggish streams. Rarely, if ever, are they found in stagnant water. The Water Mosses are so distinct from all others in their long slender floating stems and branches that no one can fail to recognize them. The species are, however, very difficult to determine, with few exceptions.

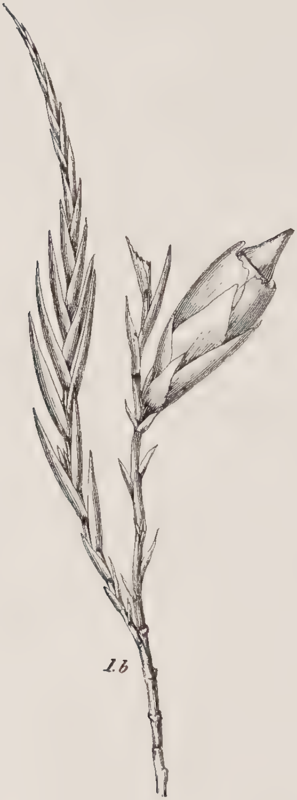

FIGURE 108.
Branch of *Fontinalis dalecarlica.*

FONTINALIS GIGANTEA Sulliv., the Giant Water Moss, is common in cool brooks and is most distinct by reason of its large turgid three-cornered stems and branches. The branch shown in the plate is a very short one; the branches are sometimes a foot or more long. The Giant Water Moss rarely fruits.

FONTINALIS DALECARLICA B. & S., the Common Water Moss, is everywhere abundant and usually fruits freely, the capsules maturing in summer. As will be seen from the plate, the capsules are almost entirely covered by the perichaetium and are borne on the older portions of the plant from which the leaves have fallen. One must not be too sure that he has found this species until he has studied it with a compound microscope, as there are several other common species that are not readily distinguished from it.

F. NOVAE-ANGLIAE Sulliv., which was collected from the same brook and almost intermingled with *F. dalecarlica* which was figured natural size in the same plate. The figure of a branch of *F. dalecarlica* from the Bryologia Europea will enable one to distinguish the two species in most cases.

HEPATICAE. Hepatics.

There has been a considerable demand for a simple book on the hepatics. To meet this demand I have prepared this treatment of the subject. With a 24-power achromatic triplet I am able to make out the more minute structures mentioned in the keys. Many of these characters, especially those involving leaf structure, can not be made out satisfactorily unless the objects be mounted in water on a slide in the same manner as for a compound microscope.

In working up the key I have been surprised to find that sterile hepatics are, as a rule, much easier to identify than sterile mosses. Many of the species maturing their spores in early spring have the spores and capsules rather fully developed in the preceding autumn, so that some of the sporophyte characters are nearly always accessible. Hepatics shrivel more than mosses in drying and are best studied while fresh, especially the thalloid forms.

A few of the rare genera are omitted and some of the minute or difficult species are not included.

The Germans call the true mosses *Laubmoose*, meaning leafy mosses, and the hepatics, *Lebermoose*, or liver mosses. The name liverwort was originally applied to *Marchantia* and *Conocephalum* because of their fancied resemblance to the liver. Because of this resemblance they were supposed to be specifics for all liver troubles according to the old doctrine of signatures. From this came the Latin name *Hepaticae* and the German *Lebermoose*. "Thus does the language of ignorant superstition become the adopted language of science."

The chief distinctions between mosses and hepatics have been noted in the introduction, but a few additional notes here may prove helpful.

The hepatics may be leafy stemmed and appear much like mosses, or they may consist of a broad, flat and rather thin plant body (thallus), which is usually closely applied to the substratum. These thalloid hepatics might be mistaken for some of the foliaceous lichens, but the hepatics are always much greener, have normally no fungus constituents, and produce spores in a very different manner. Hepatics generally grow in moist situations on soil, roots of trees, and old logs and stumps, though a certain few occur on rocks and the bark of trees under comparatively dry conditions.

In the leafy-stemmed hepatics, often called Scale Mosses, the leaves are without midrib and are nearly always in two ranks and usually flattened so as to lie in one plane, but in the great majority of cases there is a third rudimentary row on the under side which are called underleaves, or amphigastria by those devoted to technical names. The seta does not, as a rule, grow much until the spores are nearly ripe, when it elongates very rapidly. The seta and capsule are of a much more delicate structure than in the mosses, so that they wither and disappear soon after the spores have escaped, but the peculiar and characteristic scales or bracts around the base of the seta often remain much longer and help greatly in identifying species. In most of the mosses, the modified and transformed archegonium wall is carried upward by the growing capsule and elongating seta and forms a sort of a hood, known as the calyptra, covering the top of the capsule. In the hepatics, the elongating seta when present and well developed, pushes the capsule through the modified archegonium wall or calyptra, which remains below as a delicate sheath about the base of the seta. Immediately surrounding the calyptra at the base of the seta is a tubular, flattened, or often somewhat three-sided organ called the inner involucre or perianth; surrounding this is the outer involucre, called simply involucre by many authors. This latter may be either tubular or composed of separate leaf-like divisions of varied shapes, called involucral leaves or bracts, or perichaetial leaves or bracts, or simply bracts. Either one, or even both, of these involucres may be lacking in some species. Instead of a perianth or in addition to it there may be in a few genera a structure known as a perigynium, which represents a hollowed-out development of the stem, whereas a perianth is considered to represent a coalescence of leaf-like organs.

So far as possible, gametophyte characters have been used in the keys and descriptions and in the great majority of cases identification is easy from this part of the plant alone.

Owing to the difficulty of getting authentic material in condition suitable for use in making drawings, many drawings have been borrowed from various sources to illustrate plants that would otherwise have been illustrated with original work.

KEY TO FAMILIES.

Plants leafy, mosslike in appearance except for the two-ranked leaves with midrib nearly always lacking Scale Mosses (*Jungermanniaceae*).

Plants consisting of a flattened green thallus, forming rosettes, or more elongate and branching, sometimes with leaf-like lobes. (See illustrations of Riccia, Marchantia, Anthoceros, etc.) A.

A

1. Capsules, if present, immersed in the tissue of the main thallus. Plants floating on the surface of still water or more or less immersed, or growing on moist ground. Riccias (*Ricciaceae*).

Capsules raised well above the main thallus. Plants often growing in moist places but never floating........ 2.

2. Stomata (in our genera) present, easily discernible with a lens as small pores on the upper surface of the rather thick thallus; capsules (in our genera) borne on a special stalked receptacle, as in Marchantia. Liverworts (*Marchantiaceae*).

Stomata not present on the thinner thallus; capsules never borne on a special stalked receptacle.......... 3.

3. Capsules usually very long, slender and erect, commonly splitting into two valves when ripe after the manner of a mustard pod, the slender hairlike columella remaining in the center......Horned Liverworts (*Anthocerotaceae*).

Capsules globular, ovoid or short-cylindric, splitting into four valves; columella lacking..Thalloid Scale Mosses (*Metzgeriaceae*).

RICCIACEAE.

Plants (gametophytes) land-inhabiting or aquatic, once to several times dichotomous, often forming rosettes or half-rosettes. Stomata wanting or moderately well developed. Root hairs wanting in aquatic forms. Ventral scales usually obvious. Antheridia and archegonia arising singly from the dorsal surface just back of the growing apex, soon becoming deeply immersed in the thallus, the elongated archegonium neck commonly exserted and visible with a hand lens; the walls of the efferent canal of the antheridial cavity often produced into a cylindric or conic-cylindric elevation.

Fruit (sporophyte) a capsule, without foot or seta, enclosed by the calyptra, in which the spores come to lie at maturity. Inner cells of the capsule in our species all producing spores, elaters wanting.

Stomata wanting or rudimentary; assimilative layer consisting of vertical or subvertical columns of cells bounding very narrow air-canals or consisting of larger polyhedral or sub-

clavate chambers bounded by one-layered walls; antheridia scattered . . . . *Riccia.*
Stomata moderately well developed; assimilative layer of large, irregularly polyhedral chambers, visible through dorsal epidermis as areolae; antheridia in a median ridge-like androecium; gametophyte floating or occasionally growing on moist ground . . . . *Ricciocarpus.*

RÍCCIA.

The Riccias by their close-forking habit of growth usually form rosettes on compact soil, as on and near paths, in old fields, on the borders of exposed ledges, under shrubs, on roadside banks, etc. When the plants are numerous and crowded, the rosettes become confluent and irregular mats are formed. One species is aquatic and has accordingly quite a different appearance. In the north-eastern states Riccias are annuals or are in part persistent through the winter. Ripe sporogonia may be found in summer and autumn. The following key to our nine most common species may assist in their indentification.

Plants aquatic or growing on a wet substratum, the main segments narrowly linear . . . . 1. *R. fluitans.*
Plants growing on moist or rather dry ground.
  Thallus margins naked or showing obvious latero-ventral scales, not ciliate.
    Assimilative layer with more or less wide polyhedral or clavate-polyhedral air chambers.

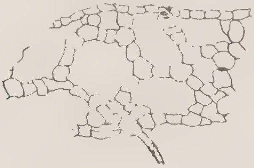

FIGURE 109.

Polyhedral air-chambers as shown in a section of thallus of *Riccia Curtisii* (After Haynes)

      Main segments 1/32–1/16 inch wide, the dorsal surface rather smooth or sometimes spongiose-alveolate with age; terminal segments mostly oblong or elliptic . . . . 2. *R. Sullivantii.*
      Main segments 1/24–1/9 inch wide, the dorsal surface soon spongiose or lacunose-alveolate; terminal segments subquadrate-obovate to obcordate . . . . . 3. *R. crystallina.*

Assimilative layer with narrow vertical or subvertical canals.
  Scales conspicuous, extending considerably beyond the margin, whitish-hyaline; main segments 1/16–1/6 inch broad . . . . 4. *R. Austini.*

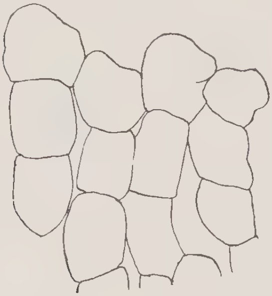

FIGURE 110. Subvertical canals as shown in a section of thallus of *Riccia hirta* (After Haynes).

  Scales usually inconspicuous, mostly hyaline, not reaching margin, or sometimes slightly exceeding it at thallus apex.
    Median sulcus (furrow) narrow and acute, the dorsal surface minutely, regularly, and compactly reticulate. . . . . 5. *R. sorocarpa.*
    Median sulcus (furrow) obtuse, commonly occupying one third or more of the width of the thallus, the dorsal surface somewhat obscurely reticulate . . . . 6. *R. arvensis.*
  Scales slightly exceeding the thallus margins, blackish purple like the margins, main segments 1/24–1/12 inch broad . . . . 7. *R. dictyospora.*
Thallus margins normally bearing a few cilia.
  Cilia stout, often curved; median sulcus rather broad, occupying 1/3–2/5 the width of the thallus; main segments 1/24–1/9 inch broad. . . . . 8. *R. Beyrichiana.*
  Cilia slender; median sulcus narrow; main segments 1/40–1/16 inch broad . . . . 9. *R. hirta.*

1. R. FLUITANS L. Fig. 111, the Slender Riccia, occurs floating or suspended in water and ponds, swamps, and slow streams. Its thallus is thin, 1/24 to 1/8 of an inch wide, 1/2 to 2 inches long, repeatedly forked, and often intertangled so as to form mats. In the ordinary floating condition it shows no root-hairs and no

reproductive organs, but when left stranded by subsidence of the water it develops root-hairs and forms spores. The capsules, with the surrounding tissue, are strongly protuberant on the lower side of the thallus. One or two recent European writers have advanced the opinion that what passes as *R. fluitans* represents in reality aquatic conditions of two or three terrestrial species. As currently understood the species is very widely distributed.

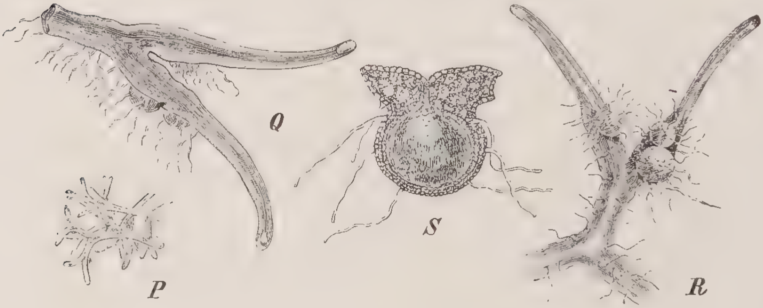

FIGURE III.

Riccia fluitans (After Bischoff.) P. Plants natural size. Q. Portion of the thallus with fruit seen from above. R. The same seen from below. S. Cross section of thallus through imbedded capsule.

2. R. SULLIVANTII Aust., Sullivant's Riccia, sometimes resembles terrestrial conditions of *R. fluitans*, but the segments of the thallus are shorter and it is more rosette-like in habit of growth. It occurs on moist compact soil and is common in the eastern and southern states.

3. R. CRYSTALLINA L., the Crystalline Riccia, has a broader and larger thallus than *R. Sullivantii* and is more quickly and more obviously spongiose or lacunose-alveolate with age. The markings of the spores are quite different, but these characters are not visible with a hand-lens. This species is widely distributed and sometimes grows in great profusion on rather soft mud on the borders of ponds and reservoirs, occasionally also on moist ground in fields or by roadsides.

4. R. AUSTINI Steph., Austin's Riccia, was formerly known in this country as *R. lamellosa* Raddi, but is somewhat different from

this European species. Its thallus is commonly broader than that of our other species and is notable by its conspicuous whitish-hyaline latero-ventral scales. Its dorsal surface is a pale glaucous-green and under a lens its surface cells give it a beautifully regular reticulation. It is of occasional occurrence on rather rocky somewhat exposed soil.

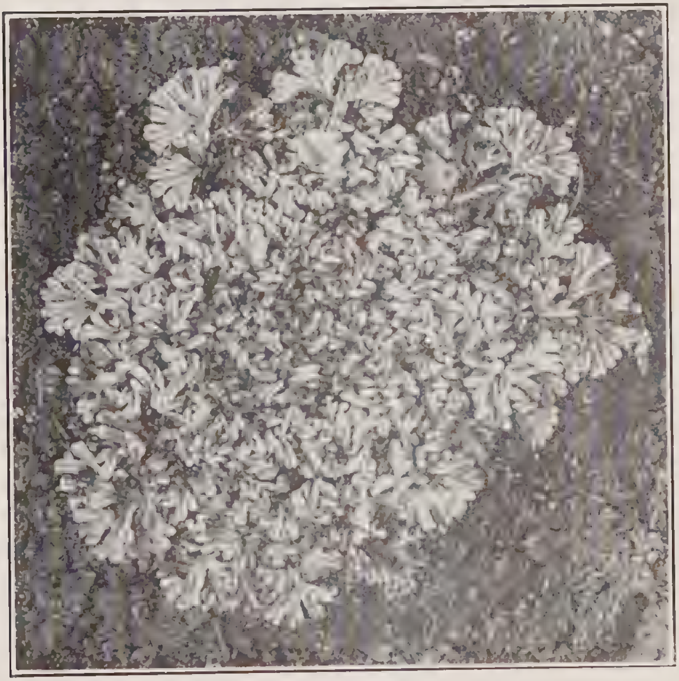

FIGURE 112.
Riccia sorocarpa Bisch, × 7/5.

5. R. SOROCARPA Bisch. (*R. minima* L. in part), the Sorus-fruited Riccia, is sometimes mistaken for *R. Austini* but it is a smaller plant with scales that are visible from above only at the apex if at all, its median furrow is more acute, and the very regular reticulation of the dorsal surface has a peculiar crystalline lustre when

living. The capsules are usually abundant and the exposed, often exserted, spore-masses sometimes form a continuous and conspicuous elongate heap in the median groove. Widely distributed and not uncommon in rather exposed places, especially about rocks and ledges. (Fig. 112.)

6. R. ARVENSIS Aust., the Field Riccia, is often found on cultivated ground that has been neglected for some months. It sometimes forms rosettes 1/4 to 1/2 inch in diameter and is sometimes in irregular mats. The color is a dull grayish green, sometimes with traces of purple at the margin. The apices of the lobes are bluntly pointed, rounded, or notched, and the median furrow occupies about one third of the width of the thallus except at the apex, where it suddenly narrows. Marginal cilia are wanting or rudimentary.

7. R. DICTYOSPORA M. A. Howe, the Net-spored Riccia, has a narrow rather sparingly forked light green to dark green thallus, 1/24 to 1/12 of an inch wide and 1/6 to 1/2 of an inch long, often with a narrow blackish purple border. The median furrow is sharply defined and acute only near the apex. There are blackish purple scales, which project slightly beyond the margins. It has been found on moist rocky soil in Connecticut and Georgia and is to be expected elsewhere.

8. R. BEYRICHIANA Hampe (*R. Lescuriana* Aust.), Beyrich's Riccia, has a medium-sized or rather large light green thallus 1/24 to 1/10 of an inch wide and 1/5 to 1/2 of an inch long, commonly tinged with red-purple on sides and margins, and bearing on its margins a few rather stout cilia. The median furrow is flat-bottomed and rather broad, occupying 1/3 to 2/5 of the width of the thallus, and is apparently closed in front by the convergence of the margins. The antheridial ostioles are elevated and easily visible under a hand-lens. The species is widely distributed and occurs mostly on rocky, rather exposed soil, often in company with *R. sorocarpa*, *R. Austini*, or *R. hirta*, or with all of these (Fig. 113).

9. R. HIRTA Aust., the Hairy Riccia, needs to be distinguished carefully from *R. arvensis* on the one hand and *R. Beyrichiana* on the other. The median furrow is usually narrower than in either, and from *R. Beyrichiana* it differs also in the smaller thallus and more slender cilia, as indicated in the key, and from *R. arvensis* also in the presence of the cilia. The sides and margins are often tinged with purple. On drying the thallus is more scurfy-white than in either of the species mentioned. There are also microscopic differences in the spore-markings. It has been reported from various

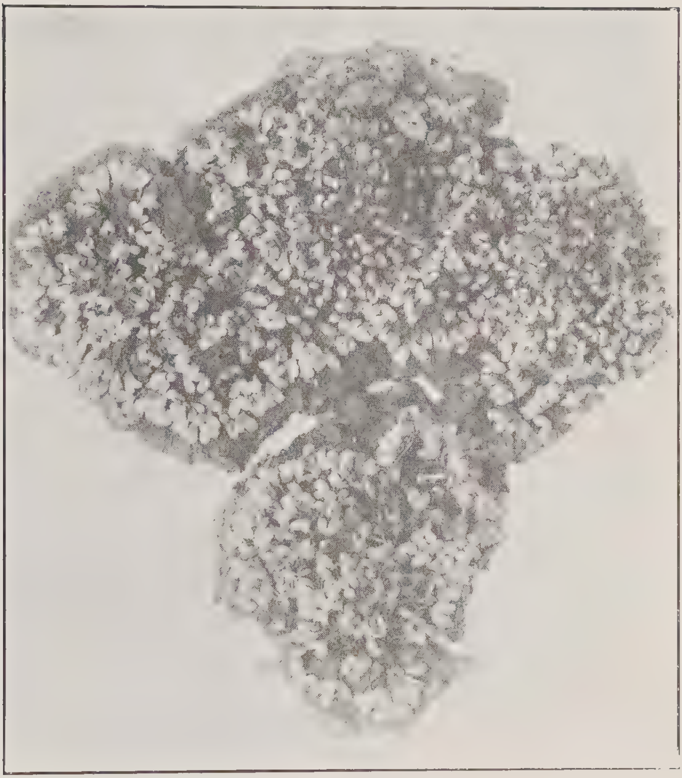

FIGURE 113.
Riccia Beyrichiana Hampe. Slightly enlarged (From Alpine, N. J.).

localities along the Atlantic seaboard from Connecticut to Texas, growing usually on rocky, exposed, or partly shaded soil. At West Hartford, Conn., it occurs in the bed of an old canal.

RICCIOCÁRPUS

RICCIOCARPUS NATANS (L.) Corda, the Purple-fringed Riccia, with its branches obcordate or wedge-shaped, 1/4 to 1/2 inch long and nearly as broad. There is a strongly marked furrow along the

PLATE LXXI.

Explanation on opposite page.

middle of each branch and an abundance of slender purplish scales underneath. The stomata are large and easily seen with a hand-lens. Frequent in stagnant ponds. A sterile terrestrial condition, is a very different looking plant, growing on mud or in very moist places, has a more elongate, several times forked thallus, with very inconspicuous scales. Its habit is so different from that of the typical floating form that it is not surprising that it has been named as an independent species, *Riccia lutescens* Schwein.

MARCHANTIACEAE.

The True Liverworts.

The plants of this family consist of a thallus of medium to large size, commonly one-half to six inches in length, usually branching dichotomously. They are attached to the substratum by numerous root-hairs and are more or less thickened in the middle to form a midrib. This in some cases is not very apparent above but shows plainly underneath. The upper surface is covered with small pores (stomata) which are very apparent with a lens, except in Reboulia. The capsules are spherical or ovoid and open irregularly by imperfect valves or teeth or by a portion of the top coming off after the manner of a lid. In this family the capsules and the antheridia are borne on special long-stalked receptacles, sometimes well illustrated by the familiar Marchantia.

An Outline of the Life-History and Structure of Marchantia polymorpha.

Marchantia polymorpha is very commonly used in botanical textbooks and laboratory guides as a type of the Hepaticae, but this is because it is widely distributed and easily available rather than because it is a fair sample of the liverwort group. Marchantia represents one end of a special line of development of a group of Hepaticae that is small in number of species as compared with the Jungermanniaceae. In the Sullivant Moss Society's "Exchange List of Hepaticae Found in the United States, Canada, and Arctic America," compiled by Miss Caroline C. Haynes and revised by

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Explanation of Plate LXXI. *Ricciocarpus natans.* Above, photo by Miss Helen E. Greenwood, × 1. Below, terrestrial form, × 7/5.

Plate LXXII. *Marchantia polymorpha* in situ.

Professor Alexander W. Evans, 333 species of Jungermanniaceae and only 30 species of Marchantiaceae are recognized. However, Marchantia is nearly always readily obtainable, its life-history has been worked out more thoroughly than has that of any of our common foliose liverworts, and for these reasons it may perhaps be allowed once more to serve as a type of the liverwort class.

In making the acquaintance of Marchantia, the student is likely to meet with the more or less mature sexual plant, or gametophyte—what in common parlance we refer to as "the plant"—or with a gemmiferous condition of the gametophyte that is especially common in greenhouses. In following out its life history, one might very naturally begin with the plant as one finds it, but it is simpler and more logical to begin at some definite point and it is rather customary to begin such an account with a spore.

Marchantia polymorpha is dioicous and the spores, intermingled with the peculiar, much elongated, spirally banded cells known as elaters, form yellowish fluffy masses on the lower surface of the finger-pronged female or archegonial receptacles. In the Ricciaceae and in certain genera of the Marchantiaceae and Metzgeriaceae, the spores of the various species have characteristic markings on their surface, discernible by the compound microscope rather than by the hand-lens, but in *Marchantia polymorpha*, the rounded or slightly angular spores are nearly smooth. The early stages in the germination of the spores may be observed upon a moist blotting paper, in a preparation of agar-agar, or in other culture media. The early stages occur more or less as represented in plate LXXIII, figures 1–11. A protonema, as exhibited by Musci, may hardly be said to exist.

Development from Spore.

The first outgrowth from the germinating spore (Pl. LXXIII, figs. 4, 5, 7) normally becomes the first root-hair. The germ filament, in the strict sense, usually consists of one, two, or three cells, the length of which depends upon the intensity of the light, being shorter in a strong light and longer in a weak light. In the end cell of the germ filament, if conditions are favorable, an oblique wall is laid down and then another at about right angles to it. Both of the two new walls are perpendicular to the plane in which the new germ disk is being developed and they help to bound a wedge-shaped apical cell (Pl. LXXIII, figs. 6–9), which for a time is to play a peculiarly active and determinative part in the development

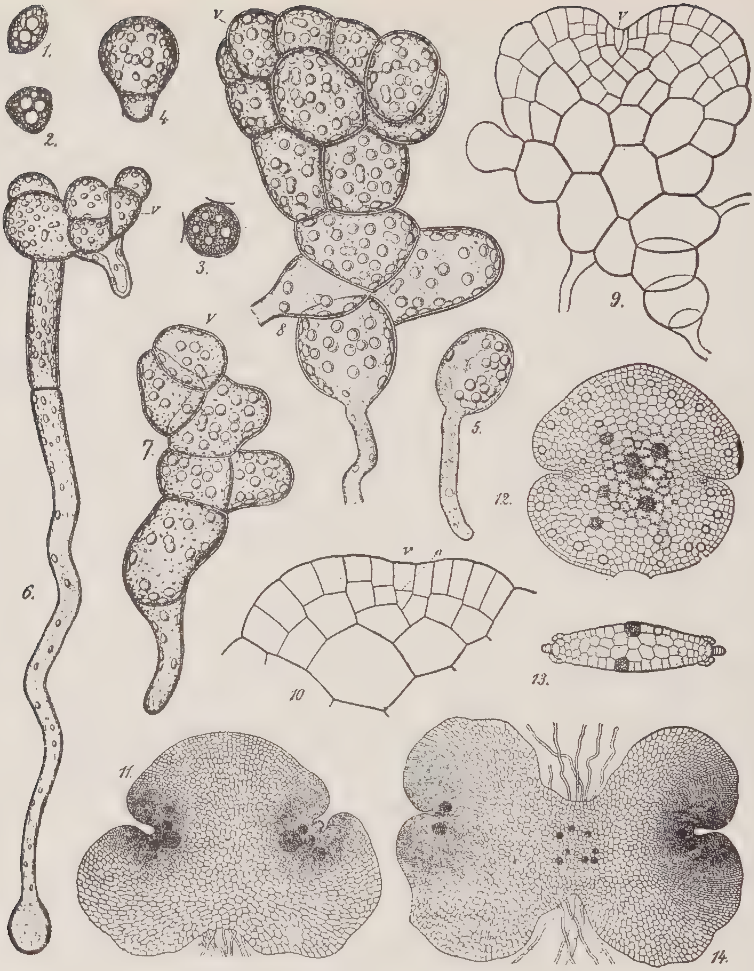

Plate LXXIII. *Marchantia polymorpha* (From Kny.).

1 and 2, ripe spores. 3 and 4, spores beginning to germinate. 5, spore, with germ tube or first root-hair. 6, a germ disk, as formed when spores are crowded and illumination is poor; in this case the germ tube does not become the primary root-hair; at V the apical cell is differentiated. 7, a germ disk as formed in a strong light; at one end is the primary root-hair, at the other the apical cell. 8 and 9, larger germ disks or young gametophytes, formed under good illumination. 10, the apical region of a young thallus, with the apical cell becoming less easily recognizable. 11, a young thallus, derived from a spore, showing first dichotomy and the beginnings of air-chambers and stomata in the two apical regions. 12, a gemma in surface view, showing the two opposite lateral indented growing points, the granular superficial cells that are to form the root-hairs, and oil-body cells near the margin. 13, a section passing through the two growing points of a mature gemma. 14, a young thallus derived from a gemma, with opposite directions of growth. Figs. 1–5, 7, 8, and 10, × 2050; 6 and 9, × 1200; 11 and 14, × 93; 12 and 13, × 386.

of the future thallus. New cells are cut off from this wedge-shaped apical cell, first on one side and then on the other, by new walls perpendicular to the plane of the disk, thus forming (Pl. LXXIII, fig. 9) a more or less heart-shaped layer of cells. Later, this wedge-shaped apical cell is replaced by a less readily recognizable apical cell from which new cells are cut off in horizontal or dorsal and ventral planes as well as in vertical or lateral planes. From this time on, the germ disk or young thallus becomes more than one cell thick as well as more than one cell broad. A little later the apical cell divides and two growing points are established (Pl. LXXIII, fig. 11) and a repetition of this process with its attendant growth and multiplication of cells results eventually in the mature thallus with its several or many forkings.

Structure of Thallus.

A highly magnified vertical longitudinal section through the growing apex of a well-developed young thallus has the general appearance of figure 1 (Pl. LXXIV). On the lower surface are sections of the ventral scales, organs which may be looked upon as rudimentary or reduced leaves. These scales originate in the median apical ventral region, but in the mature thallus some of them are far from the mid-ventral thickening known as the costa. The scales are usually inconspicuous, colorless, brownish, or rarely tinged with violet, and each consists of a single layer of cells. In Marchantia, one series of scales near each margin may be readily seen with the aid of a hand-lens and in the mid-ventral line is a double series of overlapping scales, enclosing a sort of canal in which runs a bundle of root-hairs which emerge here and there, sometimes in a diffuse scattered fashion and sometimes in tufts. There is also on each side a series of scales, usually inconspicuous, intermediate in position between the median and marginal scales.

At *St* in figure 1 (Pl. LXXIV) is a slight elevation in the dorsal epidermis, and beneath the two elevated epidermal cells is a small air-chamber. This represents an early stage in the development of one of the highly specialized air-chambers of Marchantia and of one of the peculiar and also highly specialized stomata, one of which forms a mid-dorsal opening or mouth for each air-chamber. The air-chambers here and apparently also in other members of the family arise by the splitting of internal cell walls, usually at the

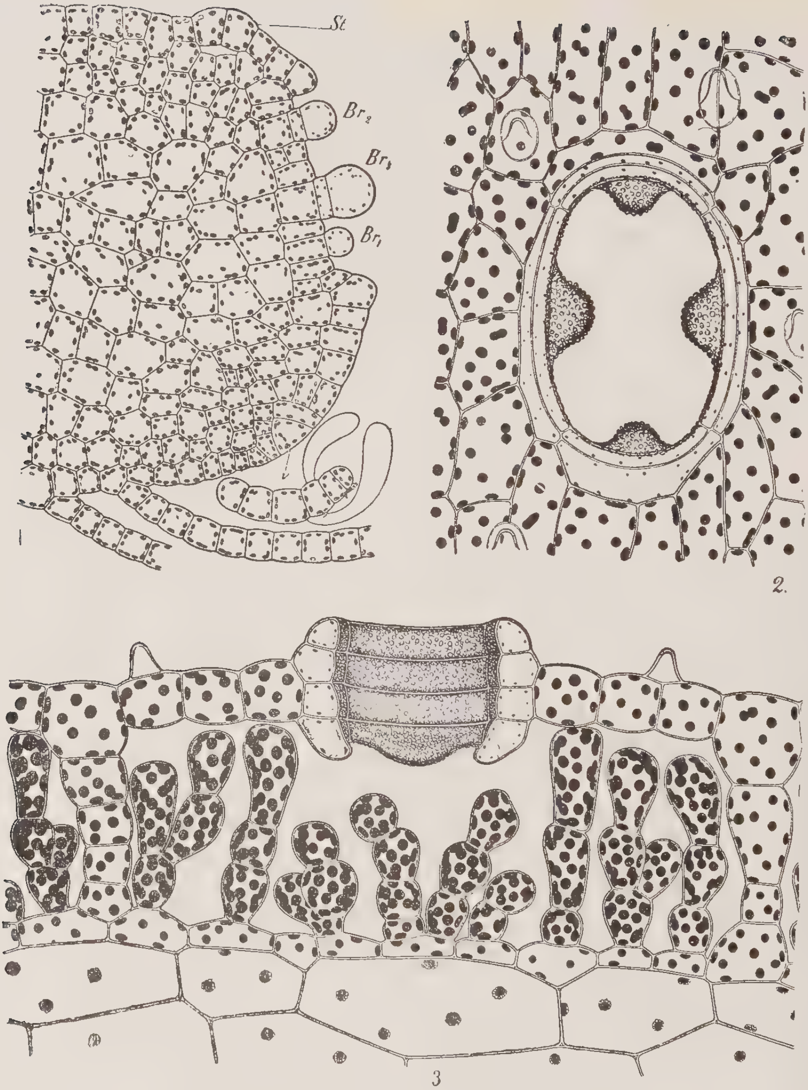

Plate LXXIV. *Marchantia polymorpha* (From Kny.).

1, median vertical longitudinal section through apical region of thallus; at *v* is one of the actively dividing cells of the growing point, below are scales in section; at *St* are beginnings of an air-chamber and stoma; the cells marked *Br* are young stages of gemmae occupying a shallow depression which is to become a gemma-cup. 2, a mature stoma in surface view, showing the not always obvious protuberances of the lowest tier of wall-cells into the interior orifice of the stoma. 3, vertical section through an air-chamber, showing the short assimilative filaments and the structure of the stoma wall. Fig. 1, × 1745; 2 and 3, × 2520.

junction of the outermost and the next subjacent layer of cells.* In a suface view of the mature thallus, the boundaries of the air-chambers appear as diamond-shaped or somewhat rhombic figures, as shown in Pl. LXXV, fig. 1. These areolae or air-chamber outlines are even more conspicuous in the thallus of the genus *Conocephalum* (Pl. LXXIX). In the genus Marchantia the pores or stomata, one near the middle of each areola, are hardly visible to the unaided eye. Fig. 3 (Pl. LXXIV) shows one of the air-chambers and its pore as they appear in a highly magnified cross-section of the thallus. In the air-chamber are few or many short filaments, usually two, three, or four cells long, springing from the floor of the chamber and occasionally reaching its roof, but usually with their upper ends free. These filaments sometimes branch in a manner suggesting the branching of yeast cells or of the green alga *Cladophora*. Their cells are richly laden with chlorophyl-bodies and it is in these cells that most of the work of assimilating food (photosynthesis) is carried on. These cells are the main starch factories of the plant. The larger cells below contain much less chlorophyl and their chief function seems to be to add mechanical strength to the plant. The walls of the stomata have a peculiar barrel-shaped form and are very different from the guard-cells of the stomata of the higher plants and from those of the stomata of the capsules of true mosses. In fact, even among the Hepaticae, such stomata are found in the vegetative thallus only in Marchantia and Preissia, though they occur on the archegonial receptacles of most of the Marchantiaceae. As shown in the magnified section, the stoma wall is made up of four (or sometimes five) layers or tiers of cells and a magnified view of the top (Pl. LXXIV, fig. 2) or bottom of the cask shows that there are usually four cells in each tier. The four cells of the inmost tier are strongly incurved and commonly have outgrowths (seen in fig. 2), which partially close the opening. The guard-cells of the pore by reason of their peculiar form or on account of their physical or chemical structure appear to resist the passage of water, as may be demonstrated experimentally under the compound microscope. The function of the pore apparatus is evidently to resist the entrance of water drops as well as to permit an interchange of gases between the air-chamber and the external atmosphere. It is probable that as in the stomata

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* See Barnes and Land. Bryological papers—1. The origin of air chambers. Bot. Gaz. **44**: 197–213. *f. 1–22.* 1907.

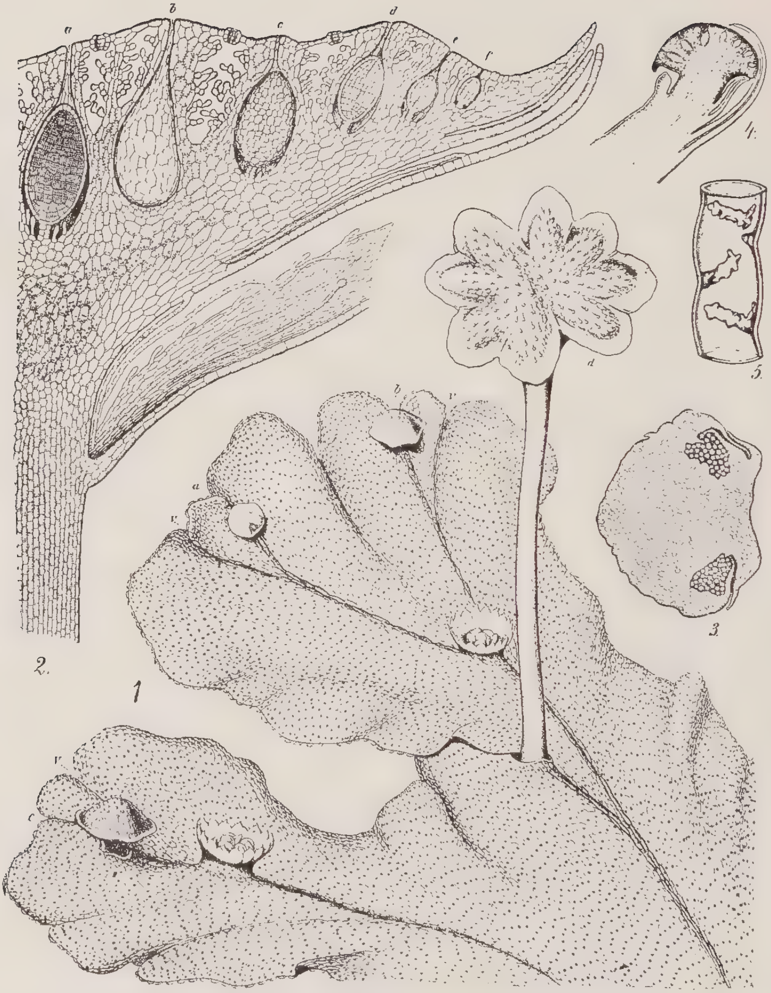

Plate LXXV. *Marchantia polymorpha* (From Kny.).

1, part of a male (antheridial) thallus, showing one mature antheridial receptacle, three immature, sessile or nearly sessile receptacles, and two gemma-cups, × 18. 2, vertical section through an antheridial disk, showing antheridia in various stages of development, × 208. 3, a cross-section of a stalk of an antheridial receptacle, showing two root-hair furrows on ventral side, × 138. 4, median longitudinal section through a young antheridial receptacle and stalk, × 68. 5, a portion of a peg-walled root-hair, in which there are somewhat spirally arranged crests or ridges instead of pegs or papillae, × 2100.

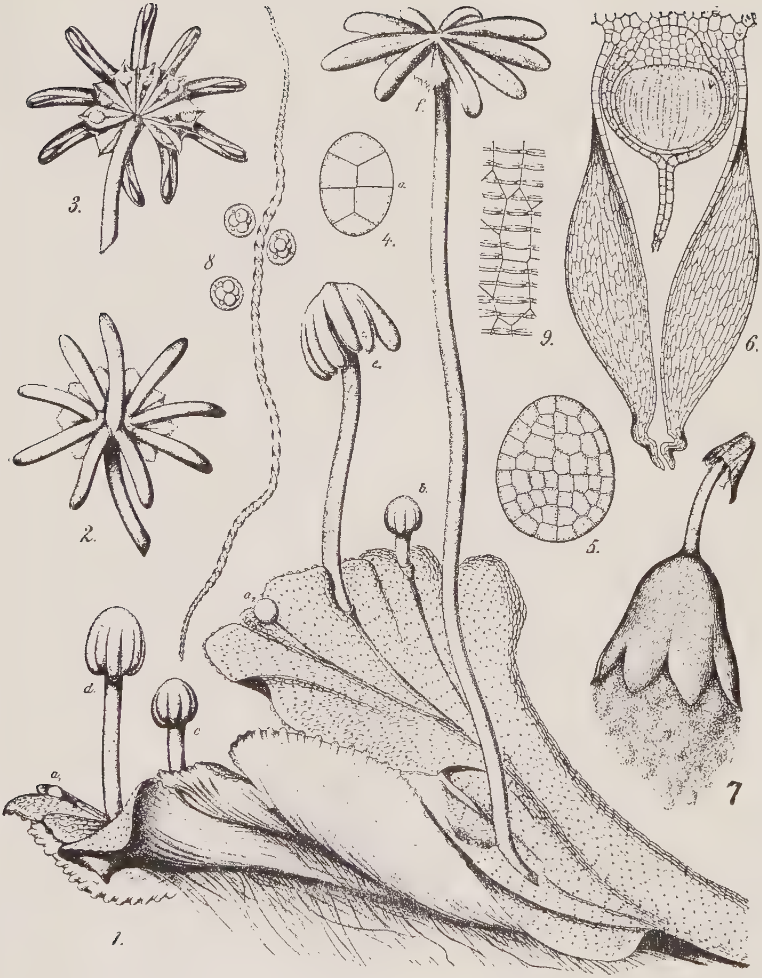

Plate LXXVI. *Marchantia polymorpha* (From Kny.).

1, part of a female (archegonial) thallus, showing seven receptacles in various stages of development. 2, a receptacle, with nearly mature sporogonia, seen from above. 3, the same seen from below. 4 and 5, young stages of a sporogonium. 6, a vertical section through a nearly mature sporogonium, its closely investing calyptra, and the pseudoperianth which loosely encloses both. 7, a mature sporogonium, the capsule now exserted through the pseudoperianth by a stalk and discharging its spores and elaters by apical dehiscence. 8, ripe spores and one elater. 9, a portion of the wall of a capsule, showing annular thickenings. Figs. 1–3, × 18; 4 and 5, × 1050; 6, × 410; 7, × 110; 8, × 1800; 9, × 700.

of the higher plants, the orifice opens and closes more or less with changing conditions of light and moisture, but whether this has been actually and accurately demonstrated in the case of Marchantia is unknown to the present writer.

Marchantia and other members of its family have two forms of root-hairs on the same plant, one with smooth walls, the other with interior peg-like papillae (Pl. LXXVII, figs. 4 and 5). Forms of an intermediate character are occasionally found. Both forms originate in the outgrowth of a single cell, which develops no transverse walls, so that the root-hairs are permanently unicellular. The smooth-walled hairs are the coarser and belong chiefly to the midrib region, while the peg-walled hairs belong chiefly to the thallus wing or lamina. The pegs or thickenings may be simple pointed papillae or they may develop branches or crests or may take the form of simple or toothed ridges, sometimes showing a tendency to follow a spiral constriction of the wall (Pl. LXXV, fig. 5). Both forms of hairs are supposed to help attach the plant and to take up water and inorganic food from the substratum. Those of the peg-walled form are thought to be better adapted for transporting liquids comparatively long distances and also for retaining water during periods of drought.

Gemmae.

Under ordinary greenhouse conditions *Marchantia polymorpha* reproduces only by multicellular gemmae or brood-bodies, which occur in dentate-margined cups (Pl. LXXV, fig. 1) on the dorsal surface of thalli. They are of frequent occurrence also on plants growing in the open, either with or without the sexual reproductive apparatus and they occur on thalli of either sex. The gemma-cups begin as depressions in the dorsal surface (Pl. LXXIV, fig. 1) near the growing apex and a careful study of their development* shows that they are not homologous with air-chambers, as has sometimes been assumed. Each gemma begins as a one-celled outgrowth or papilla which soon becomes two-celled by a transverse wall. The lower of these two cells remains undivided and becomes the stalk of the gemma which results from growth and divisions of the upper cells. The mature gemma is a flattened, somewhat fiddle-shaped disc with two marginal growing points occupying

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* See Barnes and Land, Bryological Papers—II. The origin of the cupule of Marchantia. Bot. Gaz. **46**: 401–409. *f. 1–6.* 1908.

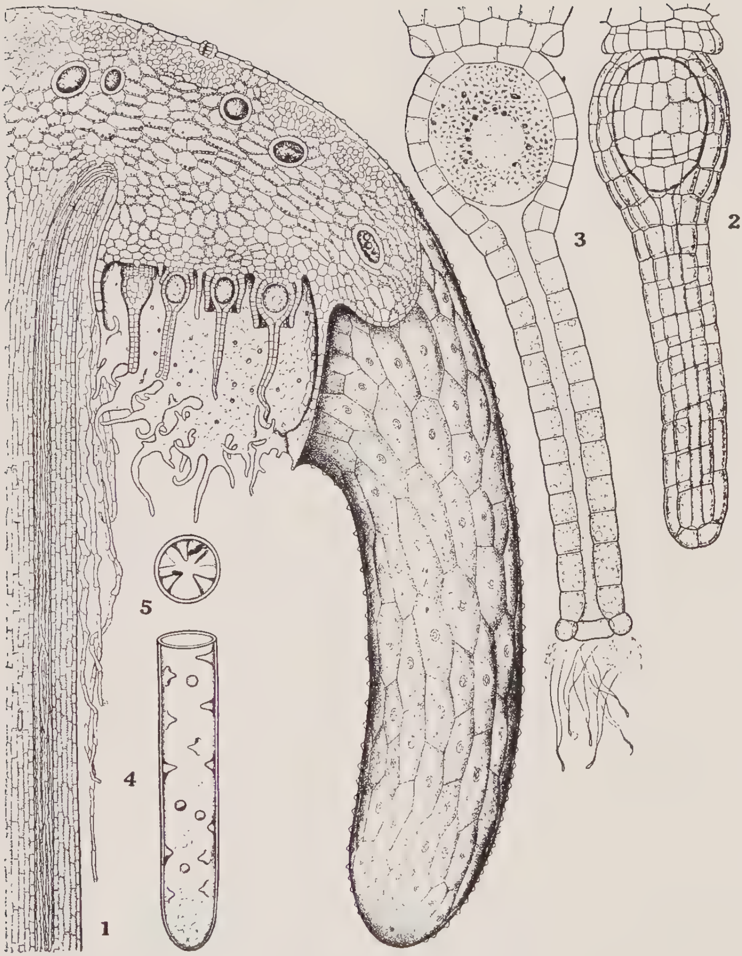

Plate LXXVII. *Marchantia polymorpha* (From Kny.).

1, median vertical section through an archegonial receptacle, showing a group of archegonia, one half of the fimbriate involucre belonging to the group, the air-chambers and stomata of the dorsal surface, oil-body cells, etc. 2, a nearly mature archegonium. 3, a longitudinal section of an archegonium, ready for the fertilization of its egg. 4, the tip of a peg-walled root-hair. 5, a cross-section of a similar root-hair. Fig. 1, × 276; 2 and 3, × 1665; 4 and 5, × 2100.

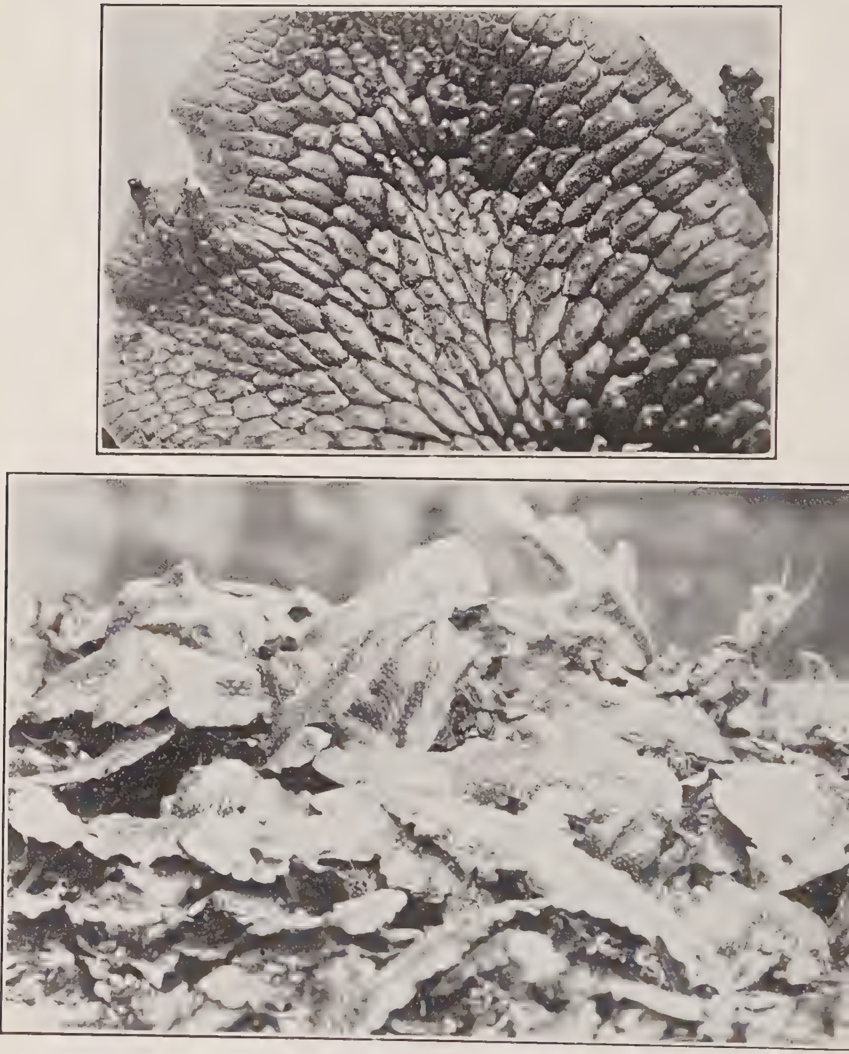

Plate LXXIX. *Conocephalum conicum.*

Above, portion of thallus, × 5. Below, × 1. Photo by Helen E. Greenwood.

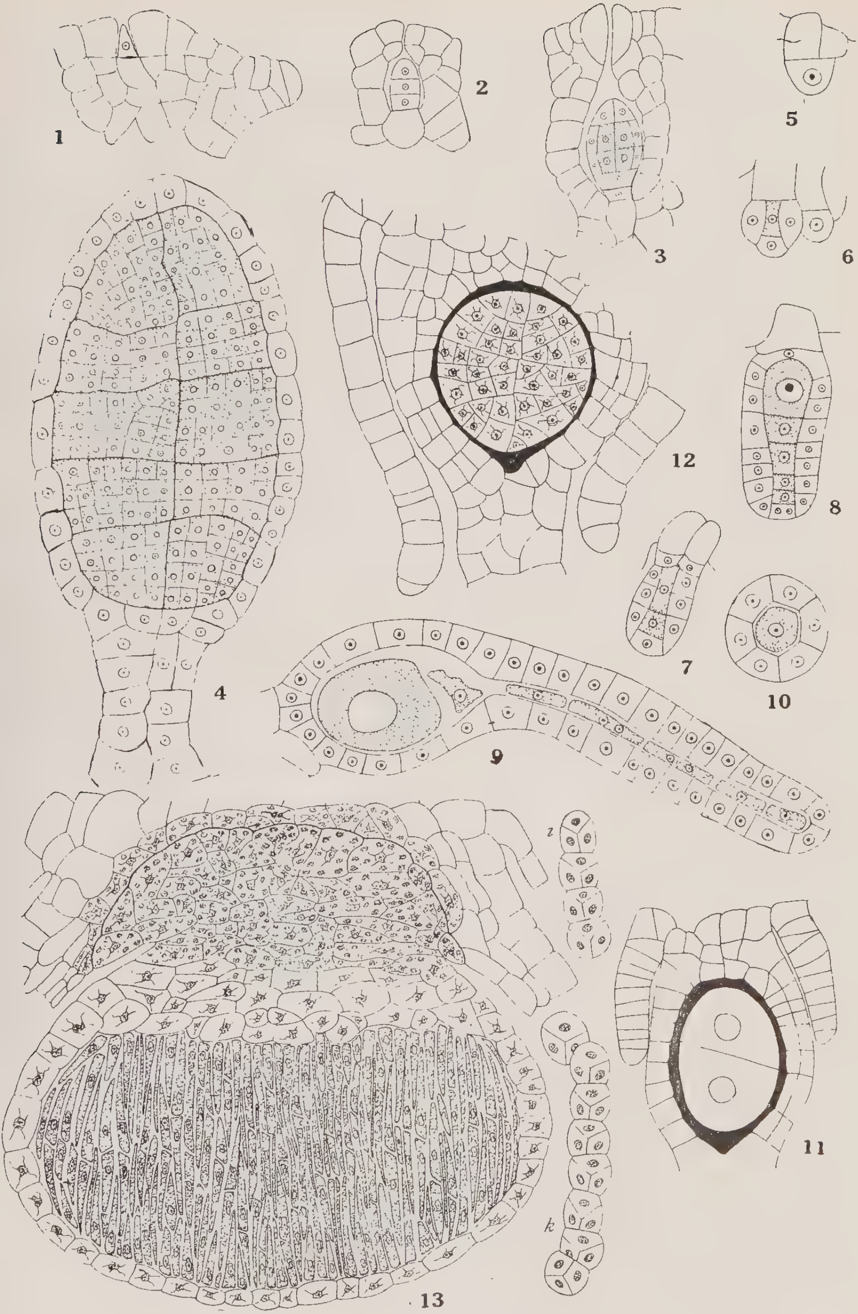
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Plate LXXVIII. Explanation on preceding page.

constant conditions most favorable to vegetative growth no gemmae or sexual reproductive organs are formed. With an increased intensity and duration of light, the sexual reproductive organs may be formed numerously, even in conjunction with a considerable amount of moisture. Under the same conditions, antheridial plants are commonly recognizable earlier than the archegonial.

Sexual Reproduction.

It is possible that with the refinements of modern cytological study some one may be able to show that the chromosomes of the cell nuclei of a male Marchantia thallus differ from those of a female thallus, as Prof. Charles E. Allen has recently done in the case of *Sphaerocarpos*, but thus far no one has been able to distinguish the sexes in *Marchantia* without awaiting the appearance of the receptacles or gametophores. In Marchantia the antheridia and archegonia are borne on special stalked receptacles, which represent modified branches of the thallus. The length of these stalks varies with external conditions, being usually longer and slenderer in moist shaded places than in a drier and better-lighted environment. The stalk or peduncle is a direct continuation of a costa and a cross section of it reveals near its anterior (ventral) surface two grooves or canals each carrying a bundle of root-hairs and each more or less closed by overlapping scales (Pl. LXXV, fig. 3), while the dorsal (posterior) surface of the archegonial receptacle shows air-chambers and stomata. The presence of two bundles of root-hairs instead of one indicates a rudimentary forking which becomes visible in the receptacle itself.

Antheridia.

The antheridial receptacle or androecium takes the form of a peltate disc (Pl. LXXV, fig. 1), furnished with scales and root-hairs on its ventral surface, and showing commonly eight short rounded marginal lobes which are sometimes reduced to crenations. The disc thus usually represents three condensed dichotomies of the metamorphosed upright branch. The antheridia are small egg-shaped bodies, visible under a hand-lens. They are immersed singly in numerous small cavities which occupy the air-chamber layer of the dorsal part of the disk, their position being indicated outwardly by slight papilla-like elevations bordering the mouths of the antheridial chambers. The antheridia are developed in acropetal succession, the youngest being near the margin of the disk, the oldest near the center (Pl. LXXV, fig. 2). To observe the younger stages in their development it is best to use the younger receptacles, although all stages are commonly found in the mature disk. The spermatozoids, visible only under the higher powers of the microscope, are narrow, slightly spiral bands, tapering gradually to a point at the anterior end to which two extremely delicate backwardly directed cilia are attached. In Conocephalum, when the moisture conditions are favorable, the spermatozoids are ejected explosively, making what look like little puffs of smoke or steam. It is probable that the same thing occurs in Marchantia, though, so far as is known to the present writer, this has not yet been observed.

Archegonia.

The archegonial receptacle or gynoecium is a finger-pronged disk (Pl. LXXVI, figs. 1–3; Pl. LXXVII, fig. 1), which, while still young and sessile or nearly so, is more or less dome-shaped, but later, after being elevated on its long stalk, is somewhat umbrella-shaped. The number of finger-like rays varies from 8 to 11, but is commonly 9. Each has a root-hair canal on or in the ventral surface. The rays and the upper surface of the main receptacle bear air-chambers and stomata. The archegonia occur usually in eight groups of several each, alternating with the rays on the under side of the receptacle. The first archegonia are formed and matured while the receptacle is still very small, and the fertilization of their egg-cells is accomplished by spermatozoids brought to the receptacles by rain-water, mostly while the receptacle is still sessile. The surface from which the archegonia arise, though apparently ventral, represents in reality an inturned portion of the dorsal surface, so that the younger archegonia in each group are found towards the stalk and the older ones towards the margin.

The Embryo.

The spermatozoids, brought to the archegonia in rain-water, swim down the canals of the archegonia, and the union of the comparatively large egg-cell nucleus with the small spermatozoid nucleus results in an embryo sporogonium (sporophyte). The transformation of a fertilized egg into a mature sporogonium is rapid, requiring only a month or two. A vertical section through a maturing sporogonium shows in the interior of the capsule a sporogenous tissue made up of elongated cells with richly protoplasmic contents.

The stouter of these cells, by usually transverse divisions, are transformed into rows of four or eight spore-mother-cells, each of which gives rise to four spores, which are at first tetrahedral and for a short time coherent. The narrower of these cells, alternating irregularly with the stouter ones, elongate to an extreme degree, become taper-pointed, develop usually two thickened spiral bands in their cell walls, and are thus transformed into what are known as the elaters. The thinner parts of their walls commonly disappear, leaving only the spiral bands (Pl. LXXVI, fig. 8). At about the time the egg is fertilized or before, one may notice the beginnings of a membranous outgrowth (Pl. LXXVIII, figs. 11 and 12) around the base of the archegonium. This eventually forms a membranous sac known as the pseudoperianth. It surrounds loosely the sporogonium, projects considerably beyond it, and is somewhat contracted at the mouth (Pl. LXXVI, fig. 6). The elongating seta, however, pushes the capsule not only through the top of the calyptra but also through the mouth of this pseudoperianth (Pl. LXXVI, fig. 7).

Several sporogonia are usually matured in each of the eight or more groups of archegonia. When fully ripe, the slightly exserted capsule ruptures at its apex, showing several teeth or short valves, and exposing the yellowish fluffy or woolly mass of spores and elaters (Pl. LXXVI, fig. 7). Hygroscopic annular thickenings in the capsule wall assist in its dehiscence. The hygroscopic elaters, with their spirally twisted bands, respond to changing moisture conditions by wriggling around and thus help to separate and scatter the spores. The spores bring us back to the starting point of this outline of the life-history of Marchantia. It is important to recognize that we have here, as in all bryophytes, an illustration of the so-called "alternation of generations." The thalli that result from the germination of spores and bear gemmae, antheridia, and archegonia, constitute the gametophytes, otherwise known as the sexual phase or sexual generation. The sporogonium, consisting of capsule, seta, and foot—everything in fact that comes from the fertilized egg—is the sporophyte. The gametophyte may reproduce itself vegetatively by gemmae or by fragmentation. The sporophyte comes only from the union of two gametes, produced, in the case of Marchantia, by two gametophytes.

tacles which bear the capsules are very different also as is shown by the figures. The capsules of Conocephalum mature in April, those of Marchantia in June and July. The stalked receptacles may assume their characteristic form much earlier. When crushed, the thallus of Conocephalum gives out a pleasant spicy odor with which as a boy I became familiar on trout-fishing trips. The source of the odor I never learned until after the second edition was printed.

LUNULÀRIA.

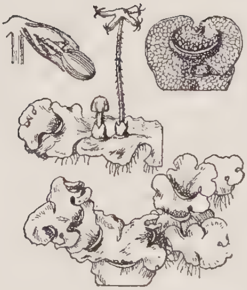

FIGURE 115.
Lunularia cruciata (After Bischoff).

L. CRUCIATA (L.) Dum. Any one who has ever had to do with greenhouses must have noted the beautiful green thalli of this plant. Small plants are sometimes mistaken for large fern prothallia, but the crescent-shaped receptacles filled with gemmae are abundant on all the larger plants and render them easy of recognition. This plant is introduced from Europe and has but once been reported as fruiting in this country. (Bryologist, Sept. 1902.)

ASTERÉLLA.

A. TENELLA (L.) P. de Beauv. (*Fimbriaria tenella* Nees) is fairly common on damp earth. The sterile fronds are often dichotomously branched and reach nearly an inch in length. The thallus is purple on the margins and has purple scales underneath. It has a peculiar rather aromatic fragrance. In fruit the fringed pseudoperianth is unmistakable. The spores mature in April and May.

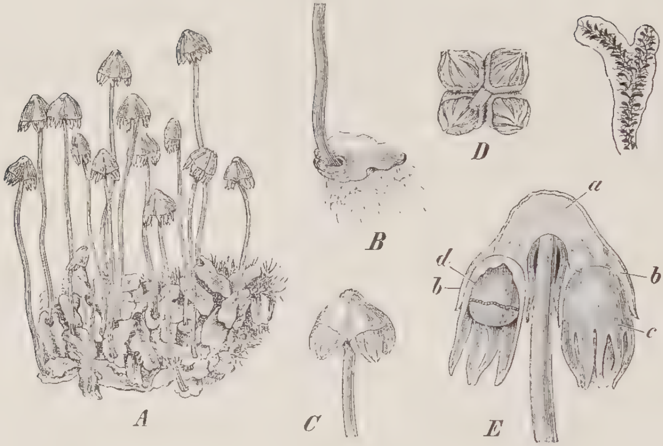

FIGURE 116.

Asterella tenella (After Bischoff). A. Group of fruiting plants, natural size. E. Section through the fruiting receptacle. The other figures are self explanatory. The drawing at the right shows underside of thallus, × 2.

PREISSIA.

P. QUADRATA (Scop.) Nees. (*P. commutata* of authors). The

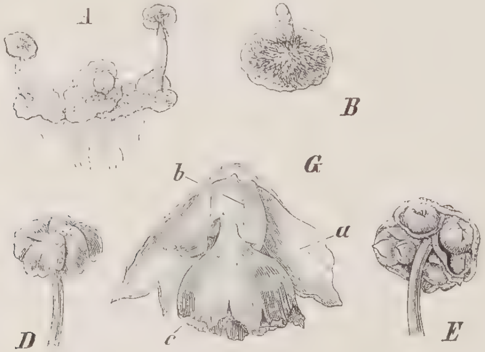

FIGURE 117.

Preissia quadrata (After Bischoff). A. Antheridial plants, natural size. B. Underside of antheridial receptacle. D & E. Fruiting receptacles. G. Pseudoperianth open; a, pseudoperianth; b, calyptra; c, capsule.

thallus varies from 1–3 inches in length and has purple margins and purple scales underneath. There are abundant raised pores all over the surface. The pseudoperianth is inconspicuous and on the upper surface of the female receptacles are ribs alternating with the lobes (four or less). The peduncle is at first covered with hairs which mostly disappear except at base and apex. The spores are mature in early spring. This species is perhaps most likely to be mistaken for Marchantia because of its large size and stalked male discs.

GRIMÁLDIA.

G. FRAGRANS (Balb.) Corda (*G. sessilis* Sulliv.) is distinguished by the peduncle, hairy at base and apex; female receptacle without alternating ribs, and antheridia in a disk immersed in the apex of the thallus. The thallus also has purple margins and purple scales. Its spores mature in May, but in the autumn the spots from which the female stalk and receptacle develop are densely covered with slender white scales, forming a whitish spot visible for several feet. In Reboulia the scales are much fewer and are more like hairs. Grimaldia and Reboulia grow especially about rocks in partly shaded or rather exposed places, where they are likely to be more or less dried up during the summer. In drying the thallus folds together lengthwise along the middle line, so that finally nothing may be seen but the under surface with its purple scales. This habit, with the protective covering of scales and certain other peculiarities of structure, saves the plants from injury during long droughts.

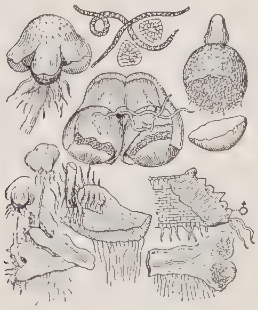

FIGURE 118.

Grimaldia fragrans (After Bischoff); part of male and female plants; section of male disk; female receptacle, etc.

REBOÚLIA.

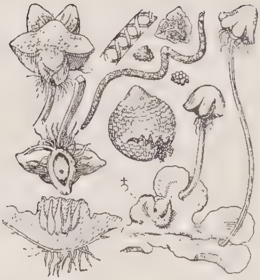

Figure 119.
Reboulia hemisphaerica (After Bischoff).

R. hemisphaerica (L.) Raddi. This species resembles Preissia in size and appearance, but is distinguished by its very small stomata, two-toothed purple scales, and sessile dusky purple male receptacles. The spores mature in late autumn.

Like Grimaldia, the thallus of Reboulia bears a number of white slender scales in autumn around the place from which the female receptacle will develop, but the scales are much fewer in number and are like hairs, while in Grimaldia they are 1/25 of an inch or more wide.

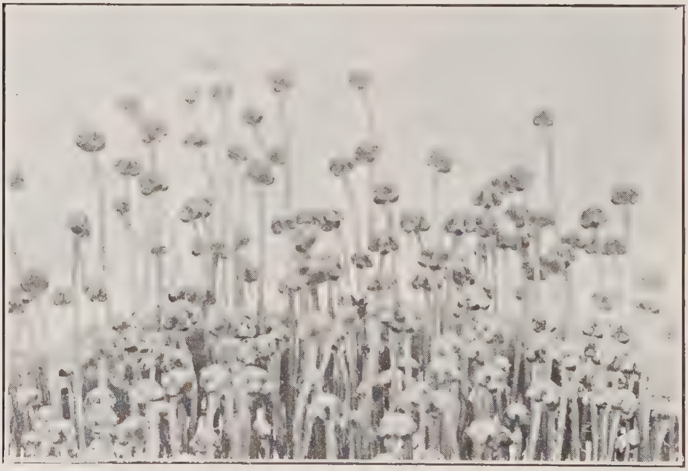

Figure 120.
Reboulia hemisphaerica. Mature sporophytic receptacles a little enlarged.

ANTHOCEROTACEAE. The Horned Liverworts.

Gametophyte a wholly leafless thallus, commonly orbicular or semi-orbicular. Antheridia and archegonia embedded in thallus; antheridia solitary or in groups of 2–4 or more in small cavities, the covering of which is ruptured at maturity. Special calyptra wanting. Involucre more or less tubular, soon broken through at apex by elongating capsule and remaining as sheath about its base or (in Notothylas) irregularly torn.

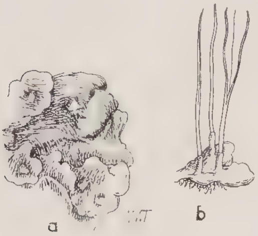

FIGURE 121.
a, Sterile and b, fertile thallus of *Anthoceros punctatus*, × 2 & 1.

Sporophyte consisting chiefly of a pod-like, usually erect and much elongated capsule, which commonly dehisces from apex downward by two valves, disclosing the spores and an axial threadlike columella. The spores ripen successively from apex of the capsule downward and are accompanied by sterile cells (pseudoelaters), which are sometimes short, solitary, and somewhat cubical, but more often form variously contorted occasionally branched filaments 2–4 (rarely up to 8 or 9) cells in length.

The presence of a zone of meristematic tissue in the capsule near its base, by the activity of which the capsule has a long-continued growth, ripening spores toward its apex while forming new spore-mother-cells below; the presence, in many cases, of stomata on the capsule, with accompanying assimilative tissue; the presence, in our species, of a single large chlorophyl-body in each cell, instead of the several smaller ones as in the assimilative tissues of the other Hepaticae, have been assigned by some writers as sufficient grounds for separating the Anthocerotaceae from the Hepaticae and giving them coördinate rank as a class. They are the highest of the Bryophyta and by many are considered as the ancestors of the Ferns, but they are put here for convenience, as they are sure to be sought with the other thalloid hepatics.

It will be difficult for the beginner to recognize the Horned Liverworts without capsules, but with a compound microscope they are easily known by the single large chlorophyl body in each cell.

This character is very plainly seen with the high power hand-lens, the whole tissue of the thallus appearing filled with large green balls, quite unlike the diffused green of other plants. In fruit, the peculiar capsule, which is responsible for the common name, is unmistakable. It splits into two halves like a mustard pod and the columella remaining in the center increases the similarity.

The family is represented in our region by two genera, *Anthoceros* and *Notothylas.* In *Anthoceros* the capsules are erect, at least when young and green, and they project far beyond the mouth of the involucre. In *Notothylas*, the much shorter capsules are horizontal-deflexed or suberect and are wholly or for the greater part enclosed in the involucre.

ANTHÓCEROS.

Five species are currently recognized in our area. When fertile and mature these may usually be distinguished with a hand-lens without any great difficulty. All ripen their spores in late summer or in autumn.

- Spores yellow.
  - Involucres 1/30–1/9 inch high, usually expanded at mouth.......................... *A. laevis* L.
    - Not uncommon on roadside banks and moist ground.
  - Involucres 1/12–1/4 inch high, scarcely or not at all expanded at mouth................ *A. carolinianus* Michx.
    - On wet ground and beside brooks, often nearly or wholly submerged, from Connecticut southward. Possibly an aquatic or subaquatic form of *A. laevis.*
- Spores fuscous or black.
  - Capsules 1/3–2 1/2 inches long.
    - Capsules 30–40 times as long as broad; thallus slightly lobed; smooth above or nearly so........................ *A. punctatus* L.
      - On moist ground. Widely distributed, though not especially common.
    - Capsules 50–70 times as long as broad; thallus more extensively lobed, with lobes, ridges, or crests on upper surface.... *A. crispulus* (Mont.) Douin.
      - On moist earth along roadsides. New England, New Jersey and Indiana, and probably not uncommon elsewhere. Close to *A. punctatus*, yet apparently distinct, though regarded as a variety until recently.

Capsules 1/8–1/4 inch long, the valves rigid or slightly flexuous when dry....... *A. Macounii* M. A. Howe.
On moist soil, especially in places subject to overflow. Quebec, Ontario, New England and Minnesota.

NOTOTHYLAS.

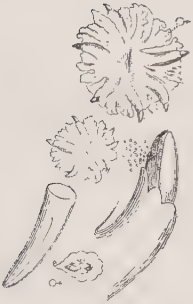

FIGURE 122.
Notothylas orbicularis (After Sullivant).

N. ORBICULARIS (Schwein.) Sulliv., which might be called the Short-horned Liverwort, is like Anthoceros except for the very short capsules which are exserted only a little way and split only half way down. The thallus is 1/4 to 3/4 of an inch in diameter; capsules 1/12 to 1/6 inch in length; spores light yellowish-brown, maturing in autumn. Widely distributed but apparently not abundant.

METZGERIACEAE. The Thalloid Scale Mosses.

The spore-bearing portion of plants of this family is like that of the Scale Mosses, but the green part of the plant is a thallus instead of a leafy stem in nearly all cases. There are, however, some intermediate forms in the family in which the thallus is divided into leaf-like lobes. The thallus is much less highly differentiated than in the Liverworts and Riccias; there are no areolae or pores (stomata) and the thallus is much thinner than in the Liverworts, in some species consisting of only a single layer of cells except at the midrib. The capsules are borne singly on setae arising directly from the thallus. They are spherical to elongated-ovoid and cylindric and remain enclosed in the calyptra until mature, when the setae rapidly elongate and break open the calyptra which is left at the base of the seta. The capsules open by four valves as in many of the Scale Mosses. A careful search of wet bare earth in shaded or springy places will nearly always yield one or more species of this family. (Fig 128.)

KEY TO THE GENERA.

1.	Thallus with a distinct midrib	2.
	Thallus usually without a distinct midrib	5.
2.	Thallus with stem-like midrib and crowded obliquely inserted, wavy, or crisped leaf-like appendages	*Fossombronia.*
	Margin of thallus entire or merely lobed	3.
3.	Thallus 1/25 to 1/12 inch wide, dichotomously branched, ciliate along the margins	*Metzgeria.*
	Thallus 1/3 to 1/2 inch wide, not ciliate at margins, entire or lobed	4.
4.	Thallus simple or only once forked, 1 to 4 inches long, prostrate; margins sinuate to entire; capsule ovoid-cylindric	*Pallavicinia.*
	Thallus dichotomously branched 3/4 to 1 1/2 inches long, often densely clustered and ascending, margins lobed; capsules oval; flask-shaped gemmae-cups often present	*Blasia.*
5.	Thallus pinnately or palmately branched, 1/24 to 1/12 inch wide (except *R. pinguis*)	*Riccardia.*
	Thallus subsimple or dichotomously branched, 1/8 to 1/3 inch in width (Fig. 127)	*Pellia.*

METZGÈRIA.

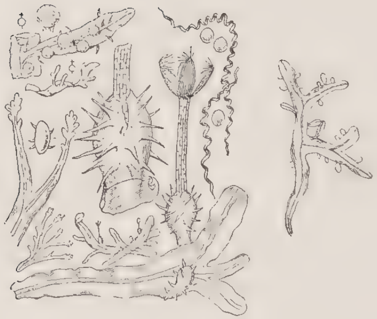

FIGURE 123.

Plants (male, female and gemmae-bearing) of *Metzgeria furcata* (After Hooker). The smallest plants are rather larger than natural size. So far as the drawings go they represent our *M. conjugata* about equally well except that *M. conjugata* is monoicous and is not certainly known to produce gemmae. The drawing by Miss Thayer at the right shows the gemmae along the sides of the thallus of *M. furcata*, × 5.

M. CONJUGATA Lindb. is the Metzgeria most likely to be found. It has a narrow (1/25 inch) thallus dichotomously branched, with very distinct midrib, and thin, usually ciliate-margined wings. The capsules arise from short branches springing from the under side of the thallus and when open bear a tuft of hairlike "elater-bearers" on the tip of each of the four valves. The calyptras are hispid, with a tiny two-lobed bract at the base. The spores ripen in summer. The plants grow on bases of trees and on rocks in damp cool places, most frequently in elevated regions.

M. FURCATA (L.) Dumort. is closely similar to *M. conjugata*, but is dioicous instead of monoicous, and bears ovate or tongue-shaped gemmae on the margins of the thallus wings.

M. CRASSIPILIS Lindb. is dioicous like *M. furcata*, but the under surface of the thallus wings is usually densely ciliate, and the gemmae are more or less circular and are borne on the upper surface of the thallus wings instead of being marginal and ovate or tongue-shaped.

M. PUBESCENS(Schrank) Raddi is distinguished from our other species by having the upper surface of the thallus wings densely covered with hairs or cilia, giving it a velvety appearance. This species is common along our North-Pacific coast and has recently been reported from New Hampshire also.

PALLAVICÍNIA.

P. LYELLII (Hook.) S. F. Gray (*Steetzia* of authors) has a flat creeping thallus, 1/4 to nearly 1/2 inch wide, sometimes reaching four inches in length, with margin somewhat sinuate, but not lobed. The thallus is very thin, almost transparent when dry, with a very conspicuous midrib and is simple, or not more than twice branched in the largest plants. Running through the center of the midrib is a strand of thick-walled cells, making a dark line that is commonly visible under a hand-lens. The capsules are cylindric with a fringed perianth surrounded by short involucral bracts. The spores are ripe in April. It is widely distributed east of the Rocky Mountains, but is probably more abundant southwards, growing among mosses in swampy places and on moist rocks and soil.

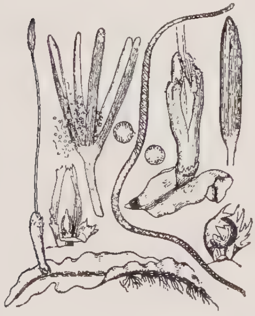

FIGURE 124.

Pallavicinia Lyellii (After Sullivant.) Plant; part of thallus with involucre; perianth and calyptra; part of perianth cut away to show young calyptra; capsule closed and open; antheridium enclosed in a leaf; elater and spores.

P. FLOTOWIANA (Nees) Lindb. has been reported from several points in

New England, and elsewhere. Its thallus is usually smaller than that of the preceding species, its margins are more sinuate, lobed, or crisped, its roothairs are colorless rather than brownish and it has an odor all its own. The costa commonly shows two interior strands of thick-walled cells, but these are not always discernible with a hand-lens.

BLÀSIA.

B. pusilla L. is one of the most common of the Thalloid Scale Mosses having a distinct midrib; the midrib is not, however, quite so conspicuous as some of the books indicate. It grows flat on the ground when the plants are few and scattered, but when crowded they become ascending and grow in thick curly tufts like miniature lettuce. The plants are dark green, or even purple, with very distinct almost leaf-like lobes along the sides, occupying from 1/4–1/2 the entire width of the thallus. If the plants be held up to the light two dark dots will usually be seen at the base of each lobe. These are peculiar structures known as "leaf-auricles" and are commonly occupied by algae of the genus *Nostoc.* The spores mature in early spring, but in July and August the young capsules can be seen inclosed in the end of the midrib in the female shoots. When ripe the capsule is elevated on a seta 1/2–1 inch in height. There is no involucre except the elevated tissue of the midrib. A fluffy mass consisting of spores and elaters often remains for some time in the center of the capsule. Flask-shaped bodies like those shown in the illustration are usually abundant on sterile stems; these bear large numbers of gemmae. Pellia often grows mixed with Blasia and as its midrib is sometimes as plain as that of Blasia it may be confused with it, but the margins of Pellia are sinuate and less plainly lobed and the roothairs are brown while in Blasia they are colorless. The dark dots at the base

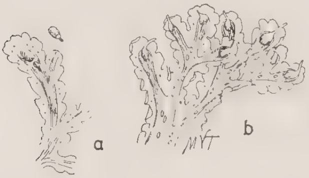

FIGURE 125.

Blasia pusilla. a, Fertile plant in August, natural size, showing capsule in position. At the side is shown the capsule removed from the thallus. b, Sterile plant with flask-shaped bodies which produce gemmae.

of the lobes distinguish Blasia from Pellia and from all other plants likely to be confused with it. Moist springy road-sides are favorable places for Blasia.

PÉLLIA.

P. EPIPHYLLA (L.) Corda, the Common Pellia, is one of the commonest objects on moist banks. It should be sought for early in May when the slender delicate setae bearing the open four-valved capsules are striking objects to one who is looking for small things. Besides the ordinary elaters, which are so small as to be scarcely recognized, there are a large number of conspicuous "elater-bearers" that remain attached to the center of the open capsule, appearing like a tuft of brownish hairs. The dark- or purplish-green thalli frequently cover the ground for several inches. The thallus may reach an inch in length by 1/2 inch in width at apex, but is usually smaller. It is simple or dichotomously branched, with margins sinuate to irregularly lobed and is nearly always notched at the end. In summer if one looks just back of this notch he will see a little flap covering a cavity in the thallus. In August the young

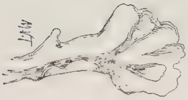

FIGURE 126.

Pellia epiphylla. Thallus, natural size, showing involucre and position of capsule as it appears in August.

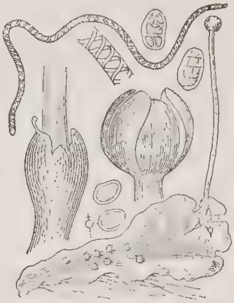

FIGURE 127.

Pellia epiphylla (After Hooker) plant; calyptra with lower part of pedicel; an elater; two spores; and two antheridia.

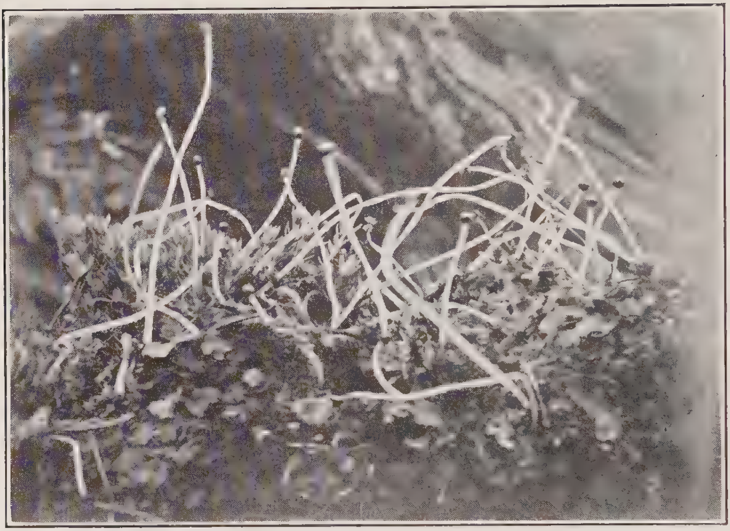

FIGURE 128.
Pellia epiphylla with sporophytes. Photo by Helen E. Greenwood.

capsule will be found in this cavity as a little round dark globule, although the spores are not ripe until the next spring. This little flap is the involucre. There is no perianth, but the calyptra is so large when mature that it might be mistaken for one. Along the center of the thallus may be seen little pimple-like elevations which indicate the places where the antheridia are produced. These are well illustrated in Fig. 127.

P. FABRONIANA Raddi and P. NEESIANA (Gottsche) Limpr. are found within our range. Both are dioicous and have none of the pimple-like antheridial dots on the plants bearing involucres. In both, the involucres are tubular as shown in Fig. 129. In *P. Neesiana* the involucre is about 1/12 inch in height and is shorter than the calyptra; in *P. Fabroniana* about twice as long and longer than the calyptra. In fruit *P. Fabroniana* is distinguished by the fluffy mass of fixed elaters remaining at the bottom of the capsule; they are nearly 1/5 inch long, two or three times as long as in the other two species.

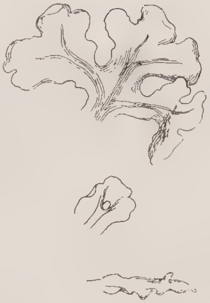

FIGURE 129.

Thallus of *Pellia Fabroniana* and portion of thallus viewed from the side, showing the tubular involucre. The middle figure shows the capsule of *P. epiphylla* in position with involucre removed. This is the condition in August. In *P. Fabroniana* the capsules have not developed at this season.

RICCÁRDIA (Aneura).

Riccardia (Aneura Dum.) differs from other members of the family in its pinnate or palmate branching. There is almost no apparent costa, the root hairs are comparatively few, and the open capsules bear a tuft of "elater-bearers" at the end of the valves as in Metzgeria. For convenience they may be divided into two groups, the first with thallus narrow, about 1/24 to 1/16 inch wide, and the second with thallus 1/8 to 1/2 an inch wide. There is little danger of confusing the plants of the first group with other plants, except perhaps Metzgeria or *Riccia fluitans*, in which the branching is distinctly dichotomous and the thallus costate.

R. latifrons Lindb. Thallus palmately divided something like the horns of a stag, about an inch long, end branches 1/12 to 1/6 inch long, about 1/25 inch wide. The spores ripen in April and May (Warnstorf). This species nearly always grows on decayed wood and the next on soil. Both favor cool moist situations.

R. multifida (L.) Dum. is one to two inches long, bipinnately branched, often much more regularly and evenly so than indicated in the figure; branches rather narrower than in the preceding; spores ripening about the same time. Usually growing on moist banks.

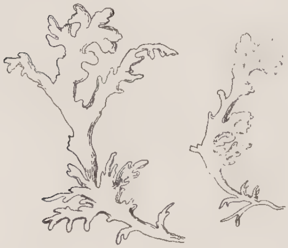

FIGURE 130.

Riccardia multifida, twice natural size.

There are two or three other species of this group within our range, but they are scarcely to be distinguished with a hand-lens.

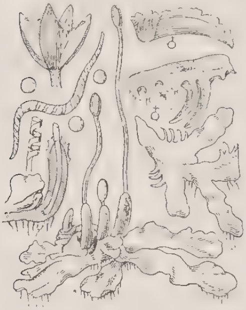

FIGURE 131.

Riccardia pinguis (After Sullivant). Portions of male and female plants; vertical section of the fleshy calyptra; male receptacle cut transversely and showing antheridia; open capsule, spores, and elater.

R. PINGUIS (L.) S. F. Gray (see Fig. 131) of the second group is found throughout our range on wet humus. It includes the *R. sessilis* of Gray's Manual.

The larger forms when sterile may be mistaken for sterile forms of Pellia and that the "Distinguishing marks are the pinnate instead of dichotomous branching, apices rounded rather than emarginate, texture more rigid when dry and a lustre as if saturated with some oleaginous compound." The thallus is 1–2 inches long and 1/8 to 1/4 inch in width. It is slightly lobed or sinuate. Spores in spring.

FOSSOMBRÒNIA.

In this genus the plant-body is so nearly differentiated into stem and leaves that its species might be easily supposed to belong to the next family, the Jungermanniaceae. However, the leaf-like parts have a less definite and regular form than the leaves in that family. The leaf-like parts are obliquely inserted, succubous, often crowded and usually wavy-crisped. The stem or midrib is commonly 1/4–1/2 inch long, and is simple or once or twice forked. The root-hairs are commonly violet-purple. The young capsule or the base of the short delicate

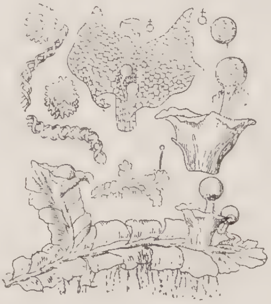

FIGURE 132.

Fossombronia pusilla (After Sullivant).

seta is surrounded by a bell-shaped or goblet-shaped involucre that is usually open or deeply incised in front. The species are best distinguished by the markings on the spores and the three or four species that occur within our range cannot well be determined with a hand-lens.

JUNGERMANNIACEAE. The Scale Mosses.

The reproductive part of the Scale Mosses, including the ripened capsule and its connected parts, perianth, involucre, etc., is essentially as in the Thalloid Scale Mosses, but the vegetative part strongly resembles the true mosses in general appearance. The leaves, however, with a few exceptions, are apparently flattened out into two rows, one on either side of the stem. They are entirely without midrib, and are frequently two-cleft or lobed or are sometimes more numerously lobed, cleft, or divided. When two-lobed, one of the lobes is often smaller and folded under the other, making the leaves "complicate-bilobed," in the language of the books; this is shown in the illustrations of Radula and Porella. This can best be made out by holding a single stem up to the light and examining with a lens, when the under lobe will show plainly as a deep shadow. In Scapania, the under lobe is the larger and the plants look as if there were four rows of leaves. The lower lobe is often called the lobule and the upper simply the lobe. Very many species have a third row of leaves on the under side of the stem, called technically "amphigastria" or underleaves; these commonly vary in size from one-third the size of the ordinary leaves to so minute that high powers of the compound microscope are needed to see them clearly; in a very few cases, they are of about the same size and form as the other leaves. The upper margin of the leaves may overlap the lower margins of the leaves next above as in Porella, or the upper margin of a leaf may lie under the lower margin of the leaf next above as in Plagiochila. In the former case the leaves are said to be incubous, in the latter succubous. As this distinction is in most cases easy to observe, it is given a prominent part in the key. Occasionally the leaves are so far apart that it is hard to determine the leaf arrangement, but a careful search will usually discover some plants in which this character can be seen. In plants with incubous leaves the young perianth is commonly turned downward; when the leaves are succubous the young perianth

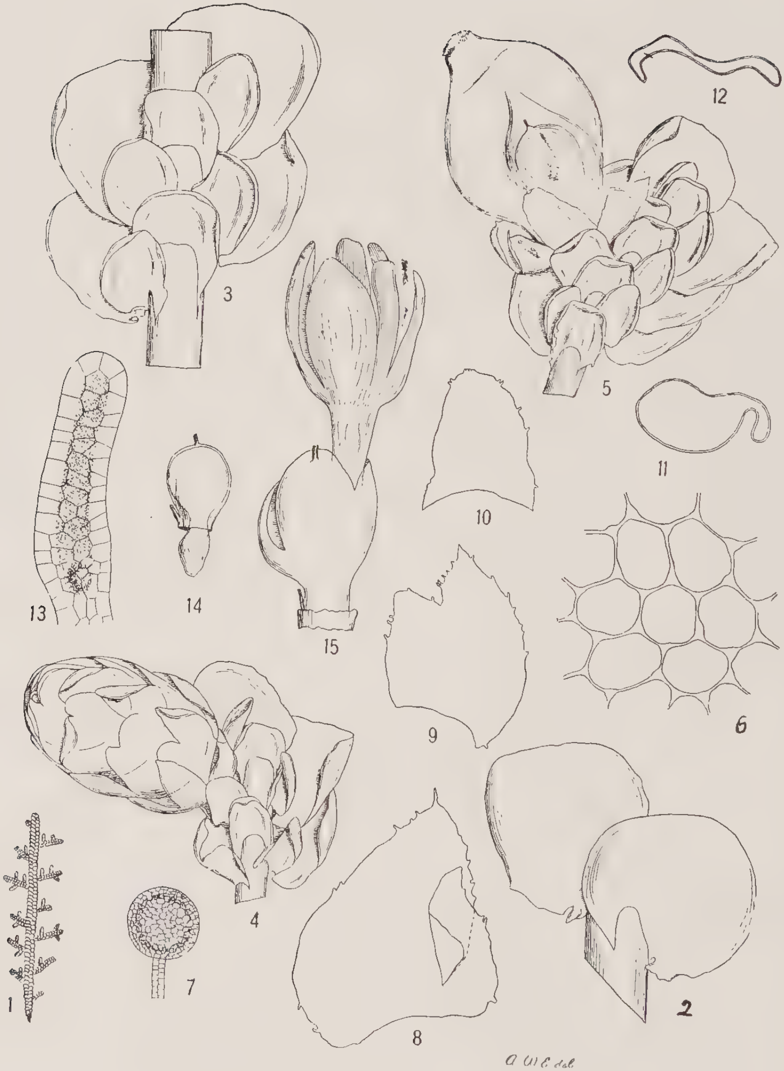
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PLATE LXXX. Explanation on next page.

is commonly turned up. So far as possible, the key has been based upon the leafy or vegetative portions of the plants, but in some few cases the characters connected with the reproductive organs and capsules are necessary to determine a plant accurately. In most cases the characters used can be determined without mounting; if, however, they can not be readily made out the parts should be mounted as for the compound microscope. If one has access to a compound microscope it will often prove a very great help, although not necessary to make out the characters mentioned. Mnium and Fissidens are sure to be mistaken for hepatics by the beginner unless the midrib of the leaves is noted.

The General Morphology of a Leafy Hepatic, Porella Platyphylloidea.

The germination of the spore, in the genus Porella, has never been described in any great detail, but Goebel states that there results from it a small ovoid cell mass. This is attached by root-hairs at one end and from the other end the leafy axis known as "the plant" or the "gametophyte" grows out. In *Radula complanata*, a few-celled disc is formed, on the margin of which is developed an apical cell from which the leafy axis arises. In only a few of the Hepaticae is there a filamentous or confervoid protonema resembling that of the true mosses.

Porella platyphylloidea resembles *P. platyphylla* (see p. 278) but is more common, occurring on tree-trunks, logs, rocks, and soil, especially in hilly regions, almost throughout the northern, eastern, and central parts of the United States and Canada. It makes thin flat mats or thick cushions and the younger growths have a way of covering or thatching the older parts, which, deprived of light, die and gradually decay. Root-hairs, springing from the bases of the underleaves, are rather rare, except in case of young plants creeping on a solid substratum, so that the thicker clumps or mats

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Explanation of Plate LXXX. *Porella platyphylloidea* (After Evans in The Plant World).

1, Male plant, × 4/5. 2, Part of stem, dorsal (anterior) view. 3, Part of stem, ventral (posterior) view. 4, Male branch. 5, Female branch with perianth, enclosing young sporophyte. 6, Cells from middle of lobe. 7, Antheridium. 8, 9, Perichaetial bracts. 10, Bracteole. 11, 12, Transverse sections of perianth, 11 at about the middle, 12 in upper third. 13, Archegonium, almost mature. 14, Young sporophyte enclosed within calyptra, an unfertilized archegonium showing at left. 15, Mature sporophyte, showing torn calyptra at base. Figs. 2–15 variously magnified.

are somewhat loosely coherent. When growing on a vertical surface, the younger or secondary branches have a way of curving outward, so that they are nearly horizontal. Our Porella ranks among the largest of our native species of leafy hepatics. The secondary stems are about 1–3 inches long and 1/12–1/8 mm. wide, including their leaves, and are irregularly pinnate (Pl. LXXX, fig. 1). A cross section of the stem shows a cortex of smaller thick-walled cells, three or four cells deep, surrounding larger thinner-walled cells. This arrangement of the cells seems to assist the stem in holding and storing water. The leafy hepatics in general show a remarkable capacity for resisting complete dessication and for reviving after long periods of drought. Even when completely dead and after being kept in an herbarium for many years, they commonly exhibit a life-like turgor when soaked in water.

The foliose hepatics in general have at the apex of each stem or branch a cell that has the form of a more or less regular triangular pyramid, and the growth and division of this apical cell are of special significance in determining the origin of branches, leaves, antheridia, archegonia, etc. The main leaves are laterally attached and two-ranked, as in most of the genera of its family, but there is also a ventral (posterior) series of well-developed underleaves and the main leaves are very deeply and unequally bilobed, so that, at first sight, if one gets a ventral view, it is easy to get the impression that the leaves are five-ranked (Pl. LXXX, figs. 3–5). In the dorsal (anterior) view, however, the leaves are very obviously two-ranked (Pl. LXXX, figs. 1 and 2). In dissecting the stem and leaves for study it is a good plan to cut across the stem carefully so as to obtain a fragment of the stem with only one or two uninjured leaves attached. Then one may find out that what looks from above like a simple entire rounded or ovate leaf really has, folded under it below, a somewhat similar but much smaller lobe that is almost separate but really connected by a narrow fold of leaf-tissue. In systematic works it is customary to restrict the term "lobe" to the larger dorsal part of the leaf, while the smaller ventral part is termed the "lobule." This peculiarity of bearing leaves with two lobes, one of which is folded under the other, is found in many of the genera of the leafy Hepaticae and such leaves are said to be "complicate-bilobed." In Porella, both lobe and lobule in their attachment seem to run down the side of the stem and this peculiarity is described by the word "decurrent." When a stem branches, the branch originates just beneath a lobe and takes the place of the lobule. An examination of the leaf-cells under higher magnifications shows more or less triangular thickenings, known as "trigones," at the angles of the cell-walls (Pl. LXXX, fig. 6).

When viewed from above, the forward (distal) margin of a lobe always overlaps the basal (proximal) margin of the next younger lobe on the same side as well as the base of the next lobe on the opposite side. This habit, together with the decurving and partial involution of the lobes in a time of drought, evidently helps to conserve the water content of the plant. The species naturally varies somewhat in closeness of its leaves or in the length of its internodes and this is especially noticeable in the case of its underleaves, which sometimes overlap and are sometimes rather widely spaced, though this difference may be due as much to the size of the underleaves themselves as to the length of the internodes. The margins of both leaves and underleaves are usually entire, but both may be slightly toothed near the base.

Porella platyphylloidea is dioicous, and the antheridial gametophytes are commonly smaller, more slender and more regularly pinnate than the archegonial. The antheridia are spherical, short-stalked, and are borne singly in the axils of saccate, densely imbricate, nearly equally bilobed and opposite light-green leaves, the ventral lobes of which are connate with the underleaves. There are usually about five pairs of these perigonial bracts, as they are sometimes called, and together with the perigonial bracteoles (underleaves) and the short lateral branch, they form a small compact spike. In median longitudinal sections of the apex of the young spike, the one-celled beginning of an antheridium may be recognized in the axil of the fourth or fifth youngest bract of *Porella Bolanderi* according to Campbell, or even earlier in *P. platyphylloidea* according to Manning. The first division of this first cell is by a transverse wall and of these two cells the outer by further divisions commonly becomes the antheridium proper and the inner one in a similar way becomes its stalk. Soon there may be recognized a differentiation between the wall of the antheridium and the central cells which later will give rise to the mother-cells of the spermatozoids. The wall of the antheridium consists at first of one layer of cells throughout, but as maturity approaches it becomes two or three cells thick in the lower part. The very minute motile spermatozoids are very similar to those already described for Marchantia. If a mature and slightly dried antheridium (Pl. LXXX, fig. 7) is placed in water it swells rapidly and bursts open in the upper part, setting free the spermatozoids.

The archegonia occur at the ends of very short branches, which until perianths have been developed are not so easily recognizable as the antheridial spikes. There are several archegonia in a group and those first formed arise in acropetal order and each from a cell close to the apical cell. Soon a central cell may be recognized, surrounded by a single layer of wall cells. The subsequent development of the archegonium (Pl. LXXX, fig. 13) is much as already described for Marchantia, except that the shape of the mature organ is more cylindrical and less flask-shaped, and there is a greater tendency for the lower part of the archegonium wall to become two cells thick. Usually only one archegonium of a group is fertilized, and the unfertilized ones may be found clustered around the base of the fertilized, even when that is represented only by the remnants of the calyptra. The fertilized archegonium is soon surrounded by an oval sac, the perianth, which has a somewhat contracted, ciliate-margined mouth. After the exsertion of the capsule, the mouth appears two-lipped or irregularly torn. A perianth may be developed even when no archegonium is fertilized. Subtending the base of the perianth is a pair of bracts (sometimes known as the perichaetial bracts to distinguish them from the perigonial), which are smaller than the ordinary leaves and less deeply bilobed (Pl. LXXX, fig. 8). Both lobe and lobule are more inclined to be acute and are more often dentate-margined than is the case with the ordinary leaves. The under-leaf or bracteole is free from the bracts and is often more or less toothed. The only other leaf or part of a leaf on the female branch in this species is usually an underleaf, which is sometimes free and is sometimes united with the subtending cauline leaf and functions as its lobule.

In its general outlines, the history of the sporophyte from the egg cell as described by Campbell for *P. Bolanderi* is about the same as in the case of *Marchantia*, already described. Three main parts are eventually recognized, (1) the foot, an ovoid or plummet-shaped enlargement at its base, which becomes immersed in the base of the archegonium and in the apex of the stem (Pl. LXXX, fig. 14); (2) the seta or stalk, which is at first a narrow neck between the foot and the capsule, but later, as maturity approaches, lengthens rapidly, pushes the capsule through the calyptra (Pl. LXXX, fig. 15) and finally lifts it above the mouth of the perianth; (3) the oval capsule, with its interior tissue, which is finally converted into spores and elaters, and its wall, consisting of only one layer of cells except at the base and splitting nearly to its base into four often irregularly cleft valves. Irregular nodulose thickenings of the cell walls of the capsule wall, through their hygroscopic properties, doubtless play a part in the splitting into valves and in the subsequent opening and closing of the valves, which movements help to scatter the spores. The scattering of the spores is aided also by the movements of the hygroscopic elaters, which in *Porella platyphylloidea* are mostly unispiral. The spores, under high magnification, are seen to be echinulate.

KEY TO THE GENERA OF JUNGERMANNIACEAE.

1.	Leaves entirely or in large part composed of hair-like divisions (easily observed if held up towards a strong light)	2.
	Leaves not as above	3.
2.	Plants grayish green, growing over the ground amid mosses in cool bogs, at least twice pinnate and somewhat resembling the Fern Mosses; leaves divided to base into hair-like lobes	*Trichocolea.*
	Plants dark green or brownish, smaller, growing chiefly on old wood and trunks of trees, but also found on humus covered stones and soil, and in bogs; leaves with a considerable undivided portion	*Ptilidium.*
	Plants exceedingly minute, looking like a filamentous green alga or moss protonema; common on decayed wood, moist soil, etc	*Blepharostoma.*
3.	Leaves incubous	A.
	(Scapania, Chiloscyphus, and Cephalozia forms may be sought here.)	
	Leaves succubous or dorsal lobes incubous	B.

A

1.	Leaves complicate-bilobed, upper lobes entire or nearly so (except Jubula). See figures and description of Porella	2.
	Leaves sometimes lobed or cleft but not complicate-bilobed	6.
2.	Plants commonly reddish-, blackish- or brownish-green, minute, leafy stems 1/25 inch or less wide, lobule like an inflated sac (Fig. 133.)	*Frullania.*
	Plants often dark olive-green, but not often blackish 1/16 inch in width, lobule not sac-like	3.
3.	Underleaves lacking; perianth strongly flattened (Fig. 138)	*Radula.*
	Underleaves conspicuous	4.
4.	Lobule with its longer edge attached to lower margin of lobe (Fig. 136); plants small; branches arising below a leaf	5.

	Lobule with its shorter margin attached to the lower edge of lobe, sometimes almost separate (Fig. 135); plants large, bi-tripinnate; branches axillary	*Porella.*
5.	Underleaves bifid	*Lejeunea.*
	Underleaves entire	*Leucolejeunea.*
6.	Leaves mostly entire or occasionally bidentate at apex	*Calypogeia.*
	Leaves strongly toothed, notched, or cleft at apex	7.
7.	Leafy stems less than 1/25 inch in width; leaves deeply 3- or 4-cleft	*Lepidozia.*
	Leafy stems 1/16 to 1/4 inch in width, with downward-growing stolons; leaves mostly 3-toothed at apex	*Bazzania.*

B

1.	Leaves complicate-bilobed, lobes nearly equal or the lower larger, giving the appearance of four rows of leaves of which the two upper are incubous and the two lower succubous	2.
	Leaves not complicate-bilobed, in some cases toothed or divided	3.
2.	Perianth strongly compressed dorsi-ventrally; not plicate in upper part	*Scapania.*
	Perianth terete or slightly compressed, more or less plicate in upper part	*Diplophylleia.*
3.	Leaves entire or slightly emarginate	4.
	Some or usually all of the leaves strongly toothed or lobed	9.
4.	Leafy stems about 1/8 inch wide, leaves oblong, plainly overlapping; on ground and over mosses	5.
	Plants about 1/8 inch wide, many leaves not overlapping, floating-aquatic	*Chiloscyphus rivularis.*
	Leafy stems 1/16 inch wide or less; leaves more nearly circular	7.
5.	Plants ascending, growing on stones and very wet soil near brooks, dark green; leaves round-ovate	*Plagiochila.*
	Plants closely applied to substratum of rotten wood, humus, or soil, sometimes creeping over other hepatics and mosses; light-green; sometimes turning dark when dried; leaves oblong to oblong-ovate	6.
6.	Perianth pear-shaped to tubular, abruptly narrowed to the minute opening	*Jungermannia lanceolata.*
	Perianth three-angled, plainly lobed at the top	*Chiloscyphus.*
7.	Leaves plainly margined, apices curved upwards toward each other when dry	8.
	Leaves not margined, apices reflexed when dry	*Jamesoniella.*

	Leaves not margined, apices curved upwards (incurved), when dry	*Odontoschisma.*
8.	Leaves obliquely attached to the stem, bordered by a single row of very large square cells which are easily seen with high power lens	*Nardia crenulata.*
	Leaves attached to the stem almost parallel with its long axis, bordered by several rows of denser cells with thicker walls	*Odontoschisma.*
9.	Upper leaves with a strongly many-toothed margin	*Plagiochila.*
	Leaves 3-5 cleft	*Lophozia barbata.*
	Leaves two-toothed or cleft	10.
10.	Plants minute, leafy stems less than 1/25 inch wide; underleaves absent or so small as to be invisible with a lens; leaves round-ovate to obovate, cleft for at least 1/4 their length	*Cephalozia.*
	(Some small species of Lophozia may be sought here, but their leaves are less deeply cleft and the plants are a much darker green.)	
	Leafy stems at least 1/25 inch wide	11.
11.	Leaves ascending, varying from bidentate to retuse or even entire near apex of stem; leafy stems 1/16 inch or more wide	*Lophocolea heterophylla.*
	Leaves all two-toothed or cleft	12.
12.	Leaves little longer than broad, concave, ascending	13.
	Leaves much longer than broad, oblong to subrectangular, lying flat on the ground (or wood); leafy stems at least 1/16 inch wide	14.
13.	Leaves subquadrate, inserted crosswise of the stem and subclasping	*Sphenolobus Michauxii.*
	Leaves roundish-ovate, inserted obliquely, not clasping	*Harpanthus.*
14.	Underleaves so large as to be made out with a lens; perianth ascending from end of stem or branch	*Lophocolea.*
	Underleaves small and not discernible with a lens; perianth buried in the substratum, attached to the side of the stem	*Geocalyx.*

* *LEAVES COMPLICATE-BILOBED.*

FRULLÀNIA.

F. EBORACENSIS Gottsche. Any one who has been in the woods at all must have noticed the pretty designs, like those in figure 1, in dark brownish-green on the bark of beeches and birches. So common and so striking is this little plant that almost no further description is needed for its identification. Although it is so tiny, its underleaves and inflated, sac-like lobules can be made out easily with a hand-lens if a specimen be mounted in water on a microscopic slide. Miss Annie Lorenz (Bull. Torrey Club **39**: 279–284. *f. 1–3.* 1912) has recently described and figured adventive branches or propagula springing from the margins of the leaves in this species.

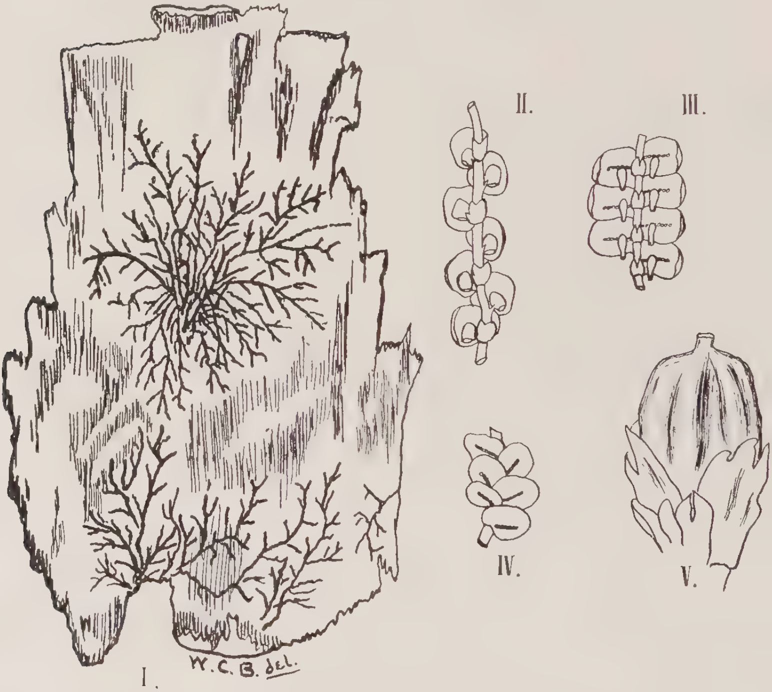

FIGURE 133.

Frullania. From Bryologist **5**: 4. 1902. I, Plant of *Frullania eboracensis*, on the bark of birch. II, Underside of same, showing underleaves and the queer sac-like inflated lobules which remind one of the bladders of *Utricularia*. III, and IV, Under and upper side of *F. Asagrayana* Mont. V, Involucre and perianth of *F. eboracensis*.

F. ASAGRAYANA Mont. is another common species somewhat resembling the preceding, but larger and usually growing on rocks, occasionally on trees. The lobule is much more elongated and

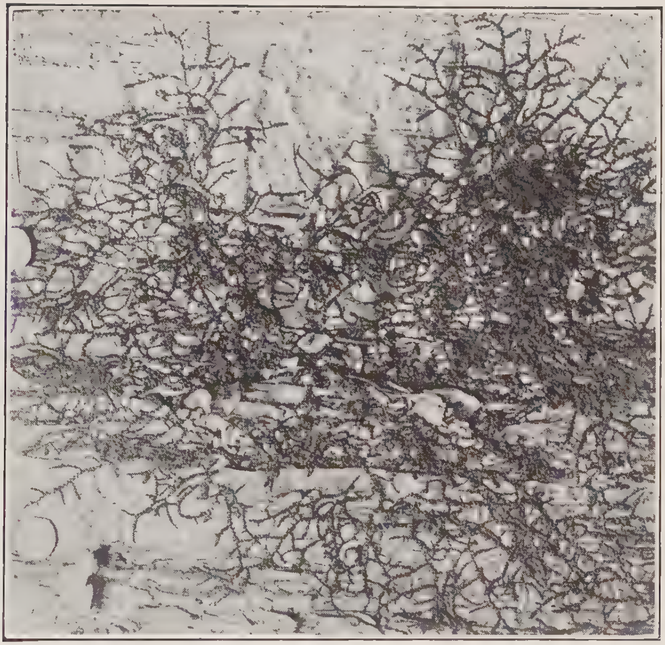

FIGURE 134.
Frullania eboracensis, × 1. On a yellow birch.

there is a line of discolored cells in the middle of the leaf that reminds one of a costa.

The lobule in Frullania is usually modified into a sac-like body of various shapes which serves for the temporary retention of water. This sac-like form of the lobule is scarcely apparent with a lens, but under the compound microscope becomes a beautiful and interesting object.

F. TAMARISCI (L.) Dumort. is close to *F. Asagrayana*, but has more sharply pointed leaves and differs slightly in more microscopic characters. It has been found sparingly along the New England coast.

There are several other species found within our range, but the compound microscope is needed for their determination.

JUBULA PENNSYLVANICA (Steph.) Evans is a plant likely to be confused with Frullania. It grows on wet rocks, especially in mountains. Its leaves, or rather the upper lobes of its leaves, are obliquely ovate, the apex varying from obtuse to abruptly apiculate, the point sometimes a tooth two or three cells long. Both lobes and lobules of the bracts are abruptly apiculate or acuminate.

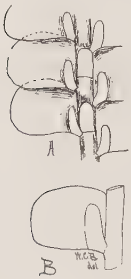

FIGURE 135.

Porella pinnata. From the Bryologist **5**: 34. 1902. A, Underside of stem, showing narrow underleaves and narrow lobules attached by their shorter edge to lobe. B, Single leaf, showing lobe and lobule.

PORÉLLA.

The Porellas differ from the Frullanias in their larger size, usually greener or yellower color, larger and entire underleaves, and lobules not sac-like, but lingulate to oblong. The lobules are plainly attached by the narrow end to the lobe and extend forward parallel with the stem. The following key may help to distinguish our three commonest species:

Lobules broadly ovate to oblong.
  Plants robust, irregularly pinnate, lobes of stem-leaves as broad as long and crispate at base, lobules about as wide as the underleaves and rounded at broad apex; cilia at mouth of perianth densely crowded; elaters mostly unispiral..... **P. platyphylloidea* (Schwein.) Lindb.
    On rocks and trees, very common, Nova Scotia to Minnesota, Florida and Arizona.
  Plants medium-sized, regularly bipinnate, lobes of stem-leaves longer than broad, slightly or not at all crispate at base, lobules narrower than underleaves and tapering toward apex; cilia at mouth of perianth scattered; elaters bispiral throughout.................... *P. platyphylla* (L.) Lindb.

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*See Pl. LXXX.

On rocks and trees, occasional, Quebec to Minnesota and Pennsylvania.

Lobules lingulate-oblong or subfalcate, minute, closely appressed to stem or to lobes, length of lobules 1/3–2/5 the width of the lobes; perianth mouth short-ciliolate, becoming crenulate with age...... *P. pinnata* L.

On banks of shaded streams and on rocks and logs subject to overflow, common from Nova Scotia to Louisiana, Illinois and Missouri.

LEJEÙNEA.

The Lejeuneas are tiny plants, our species being about 1/25 of an inch wide. They are likely to be mistaken for the Frullanias, but their lobules are not helmet-shaped, but show plainly that each is the lower part of the leaf turned under, as each is attached to the lobe by its longer edge. The underleaves are rather small and bifid. The Lejeuneas are so much smaller than the Porellas that there is little danger of confusion, but aside from this the difference in lobules noted in the key is very clear and easily made out. The color of the plants is usually lighter than in Frullania or Porella.

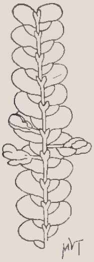

FIGURE 136.

Lejeunea cavifolia. A portion of a plant from the underside, × 6.

L. CAVIFOLIA (Ehrh.) Lindb. is found throughout our range on trees and rocks. The lobules are inflated so that in dry specimens mounted in water a bubble of air nearly always remains inside. The keel formed at the junction of lobe and lobule is strongly curved and the outline of the leaf is indented at the outer end of the lobule. The underleaves are about the size of the lobule and smaller than in the next. The spores mature in midsummer; perianths may be found in autumn and winter. The perianth is about half exserted, oblong to oval-oblong from a narrower base, rounded at the apex and contracted into a short slender beak resembling that shown in *Jungermannia lanceolata* (Fig. 159), sharply five-keeled in the upper part. The bifid underleaves which distinguish this species microscopically seem entire with a lens.

LEUCOLEJEÙNEA.

L. CLYPEATA (Schwein.) Evans is a rather larger pale green plant found on rocks and trees, from Massachusetts southwards. The lobule forms an almost straight keel and the lower (postical) margin of the leaf is much less incurved. The underleaves are much larger than the lobules and are entire-margined. The perianth has a rather shorter and broader beak.

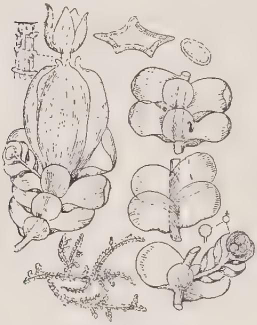

FIGURE 137.

Leucolejeunea clypeata (After Sullivant). Plant; portion of stem with two pairs of leaves seen from above; the same from below; portion of a stem with a pair of leaves and a male branch; perianth with capsule and bracts; cross section of perianth; elaters and spores.

COLOLEJEUNEA BIDDLECOMIAE (Aust.) Evans, one of the most minute of our leafy Hepaticae, is beyond the hand-lens unless it may be recognized by its very minuteness. The tiny creeping fronds are about 1/70 to 1/50 of an inch wide. The dorsal lobes are ovate or decurved-falcate. Under a higher magnification, one may discover that it has no underleaves and that its leaf-cells are protuberant and that each is crowned with a papilla. It is not uncommon, but is ordinarily overlooked. It occurs on rocks, stones, and the bases of trees. It is found especially on the bark of trees in cedar swamps.

RÁDULA.

R. COMPLANATA (L.) Dum., is fully as common as the Common Porella, growing on stones, walls, and roots of trees in dark green mats. The leaves are complicate-bilobed as in all the preceding members of the family, but there are no underleaves and the root hairs are all attached to the lobules instead of to the stem or underleaves as is usually the case. The lobule is attached by the longer margin as in Lejeunea, but the plants are much larger. The spores mature in early spring, but perianths can be found on the plants at almost any season and they are so characteristic as to render recognition easy. They are flattened at the mouth (not well shown in the figures) as if someone had taken them between the thumb and finger and squeezed the upper portion flat. The mature capsules are only slightly exserted from the mouth of the perianth. Besides the spores, the plants often produce gemmae from the leaves as shown in the figures.

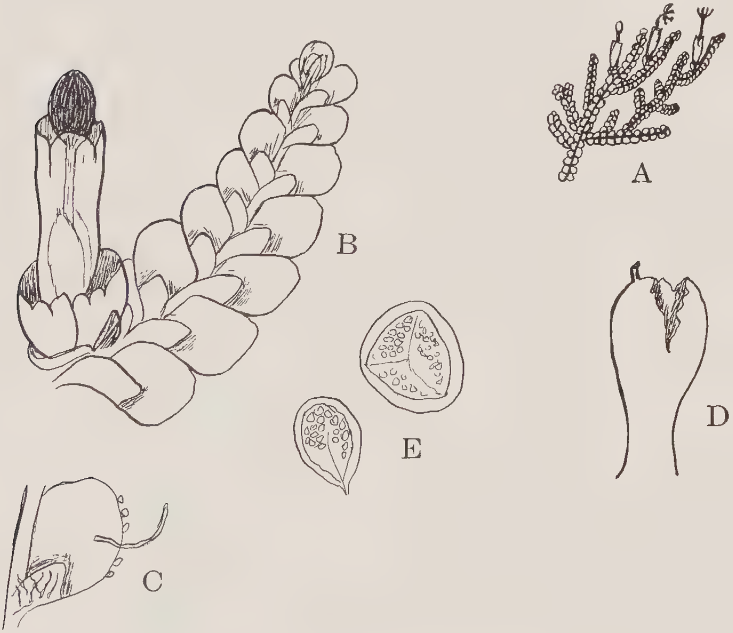

FIGURE 138.

Radula complanata. A, Plant, natural size. B, Branch with fruit, showing clearly the seta and capsule, with the calyptra at base of seta showing through the transparent flattened tubular perianth, and at base of the perianth, the involucre. This is a ventral view and shows well the small ventral lobule of each complicate-bilobed leaf. C. Leaf showing lobule with roothairs and larger lobe with gemmae along the edge. This illustrates the simplest form of a "complicate bilobed" leaf. There are no underleaves. D, Calyptra. E, Spores, highly magnified.

SCAPÀNIA.

The Scapanias are large hepatics with the leaves complicate-bilobed, but the upper lobe the smaller, so that there appears to be four rows of leaves instead of two. The lower lobes are succubous while the upper sometimes appear incubous. The margins of the leaves are usually dentate or ciliate-dentate. There are no underleaves.

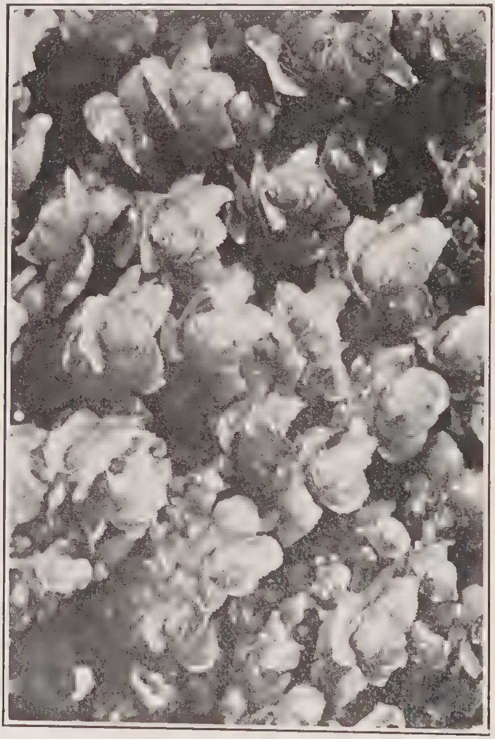

FIGURE 139.
Scapania nemorosa, × 5. (Wet with dew.)

S. NEMOROSA (L.) Dum., the Common Scapania, grows on rocks and moist banks. The lower lobes are distinctly longer than broad and are strongly ciliate-dentate. The leaves are stiff and only a little larger above. The perianth mouth is ciliate-dentate. The spores mature in spring. Several closely related species are now currently recognized among the plants formerly referred to *S. nemorosa*. The characters differentiating them can not well be made out with a hand-lens.

S. UNDULATA (L.) Dum., the Aquatic Scapania, is less common than the preceding and grows on stones in streams or in very wet places. It is green, or frequently red or dark brownish-red. The leaves are flaccid and distant below, increasing in size and density above. The upper lobe increases proportionately in size above and in some cases the lobes become subequal; the margins are never so strongly dentate as in the preceding, and the lower are frequently nearly entire. The lower lobes are as broad as long or even broader. The spores mature somewhat earlier than in the preceding. Our figure of the entire plant is too small; plants are often found twice as large.

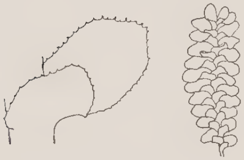

FIGURE 140.
Scapania nemorosa. Branch, × 2. Leaf, × 10.

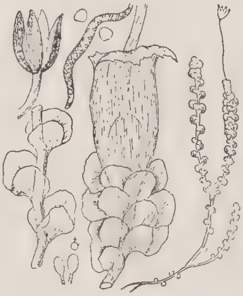

FIGURE 141.
Scapania undulata (After Hooker).

Other species of Scapania, less common or less easily determinable, occur within our range.

DIPLOPHYLLEÌA Trevis. (*Diplophyllum* Dum.)

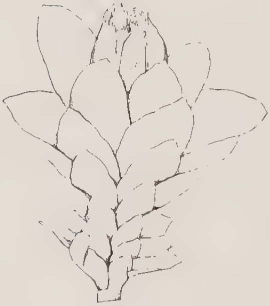

FIGURE 142.
Diplophylleia apiculata Evans, × 18. Dorsal (antical view) (After Evans).

The Diplophylleias much resemble the Scapanias when sterile but may usually be distinguished in our commoner species by the narrower more pointed dorsal lobes, which make more nearly right angles with the ventral lobes, and by the more sharply folded keel.

D. TAXIFOLIA (Wahl.) Trevis. occurs on shaded rocks and is widely distributed. The ventral lobes have rounded or occasionally subacute points and the species is dioicous.

D. APICULATA Evans is found chiefly on shaded banks, often under shrubs and about the bases of trees. The plants are rather smaller than in the preceding, the ventral lobes of the leaves are commonly apiculate, and the species is monoicous. It is not uncommon in the eastern and southern states (Fig. 142).

***LEAVES DIVIDED INTO HAIR-LIKE DIVISIONS.*

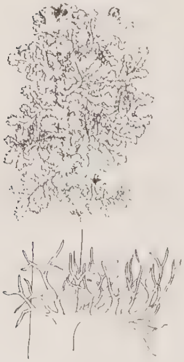

FIGURE 143.
Trichocolea tomentella a little enlarged and leaf much enlarged.

TRICHOCÒLEA.

T. TOMENTELLA (Ehrh.) Dum., the Woolly Hepatic, derives its name from the fact that the leaves are divided into very numerous hair-like segments. It is a large plant somewhat resembling the Fern Mosses in its pinnate branching. It is a beautiful gray-green, twice or more pinnate, and when held up to the light the fine hair-like structure of the leaves is easily apparent. There is no perianth and the bracts coalesce into a hairy tube attached to the calyptra. The spores mature in early spring. Frequent in swamps on the ground and over mosses. Although the plants are very distinct from everything else it is very difficult to get a drawing that represents them satisfactorily. See Pl. A, p. xvi.

PTILÍDIUM.

P. PULCHERRIMUM (Web.) Hampe also has its leaves divided into hairlike divisions, but a considerable portion of the base of the leaf is undivided. The plants are small, about 1/25 of an inch wide, dark green or brownish, with leaves spreading when moist, closely imbricated when dry. The perianth is obovate, with a fringed mouth. The spores ripen in early spring but the capsules may be found in autumn. The capsule in the illustration was collected in August. *Ptilidium pulcherrimum* is very common on logs, tree-trunks, fence-rails and stones. It fruits very freely and the slender white setae surmounted by the black capsules are conspicuous objects to one who goes botanizing in early spring. *P. pulcherrimum* has been considered by some writers to be a form of the next species. (Fig. 145.)

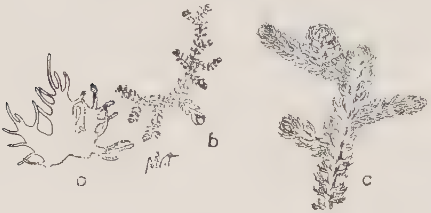

FIGURE 144.

Ptilidium pulcherrimum. a, Leaf, × 37. b, Plant with perianth and young capsule, × 2. c, Portion of plant, × 5.

P. CILIARE (L.) Nees is more common to the northward and grows on moist earth or in bogs. According to Evans, it "grows in loose tufts, which are often three inches or more in depth," while the depressed mats of *P. pulcherrimum* are rarely more than half an inch thick. Its stems are erect, while those of *P. pulcherrimum*, except branches bearing perianths, are prostrate. The stems also are less branched and the leaves are distant or loosely imbricated.

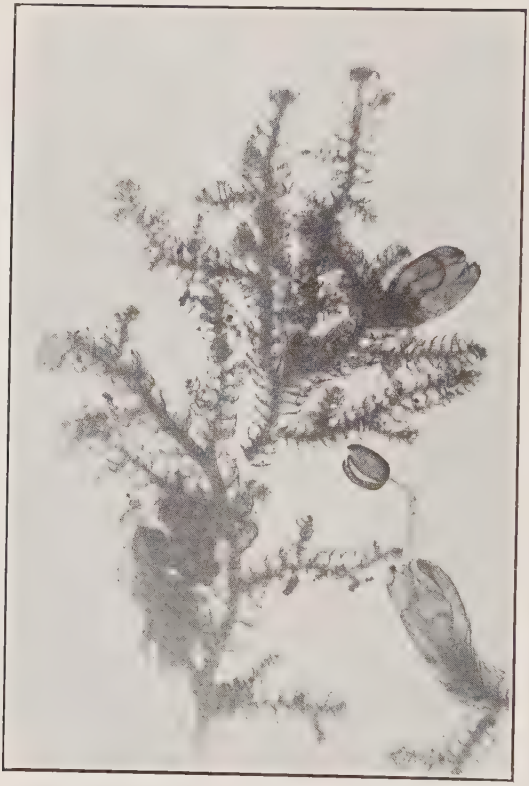

FIGURE 145.
Ptilidium pulcherrimum by transmitted light, × 7.

BLEPHARÓSTOMA.

B. TRICHOPHYLLUM (L.) Dum. is a third species with leaves divided into hair-like segments. It is the tiniest of them all and looks more like a beautiful green alga than an hepatic. With the hand-lens the illustration will do more to help recognize it than volumes of description. It is very common on moist earth, stones and decaying wood and usually grows so far apart that the stems appear separate instead of forming mats. The spores mature in early spring, but the perianths are well formed in August.

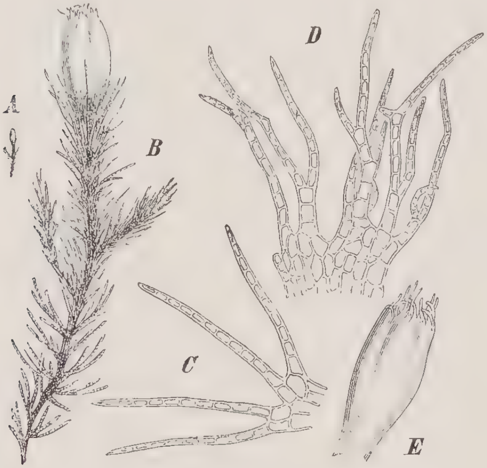

FIGURE 146.

Blepharostoma trichophyllum (After Schiffner). A, Plant natural size. B, The same, × 8. C, Leaf, × 50. D, Bract. E, Perianth, × 17.

****LEAVES NOT COMPLICATE-BILOBED OR FINELY DIVIDED,* INCUBOUS.*†

LEPIDÒZIA.

L. REPTANS (L.) Dum., the Common Lepidozia, is about the size of Ptilidium, but is much less frequent and is in no danger of being confused with it, for the 3- to 4-cleft leaves curved downwards and looking like a half-closed hand are easily made out with a lens. The Common Lepidozia sometimes grows in tufts or mats, but at first it makes a delicate tracery over the earth or rotten wood on which it grows, unless it be obscured by other plants. The underleaves are cleft much like the others, but are smaller, usually about one half as broad (commonly larger than shown in our figure). The bracts are also cleft like the others, but are much larger and proportionately longer. The perianth mouth is contracted and very minutely denticulate. At first sight this species might be mistaken for a Cephalozia, but a close examination of the leaves will at once show the difference. Dr. Alexander W. Evans says: "A peculiar habit of the plant is the way in which its prostrate stems creep over tufts of mosses and other hepatics, the tufts thus encroached upon are in time completely covered by the Lepidozia, and, as their supply of light is cut off, they become feeble and finally perish. It is among these crowded patches, and particularly those which grow on rotten logs, that we must look for fruiting specimens, the plants on shaded rocks being almost invariably feebly developed and sterile."

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* Except Lepidozia species.

† Except Cephalozia.

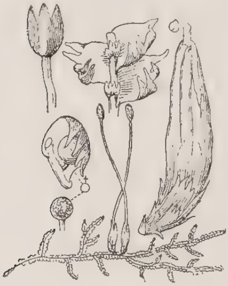

FIGURE 147.

Lepidozia reptans (After Hooker). Plant; portion of stem with leaves and underleaves; antheridium with its leaf, and free; perianth with involucre; capsule, elater, and spores.

L. SYLVATICA Evans (*L. setacea* of Gray's Manual) is common on shaded banks and rotten logs. It might be mistaken for Blepharostoma, but it grows in *dense tufts* and the divisions of the leaves are shorter and, except for the apical half or third, are two or three cells wide instead of one as in Blepharostoma. It differs from *L. reptans* in its smaller size and in its more slender leaf-segments which are only one cell wide in their apical parts.

L. SETACEA (G. H. Web.) Mitten occurs in bogs and is apparently rather rare in America. It differs from *L. sylvatica* in its usually 4-cleft instead of usually 3-cleft underleaves, in its commonly 3- or 4-cleft instead of 2-cleft bracts, and in other characters not well determined with a hand-lens.

BAZZÀNIA.

B. TRILOBATA (L.) S. F. Gray, the Three-lobed Bazzania, is one of the largest of the scale mosses of our region. It is common on the ground in cool moist ravines, swamps, and woods, but reaches its perfect development in the deep mountain woods of New England and similar regions elsewhere. Here it forms deep soft dark-green carpets over earth, stones, old logs, and debris. The erect ascending stems are 2–5 inches long and 1/8 inch or more wide with the leaves. The under sides of the stems bear numerous slender flagella with tiny leaves; these the uninitiated are apt to consider as roots. As its name indicates, the oblong-ovate truncate leaves are three-toothed at the apex, but these teeth are not large enough properly to be called lobes. The leaves are plainly incubous as shown in the figures, and somewhat deflexed, i. e., bent toward the ground. The underleaves are easily seen. The spores mature in August and September. The Three-lobed Bazzania is quite variable in size and in unfavorable localities is so small that the beginner may call it the next unless he has seen both and remembers that *B. tricrenata* is subalpine.

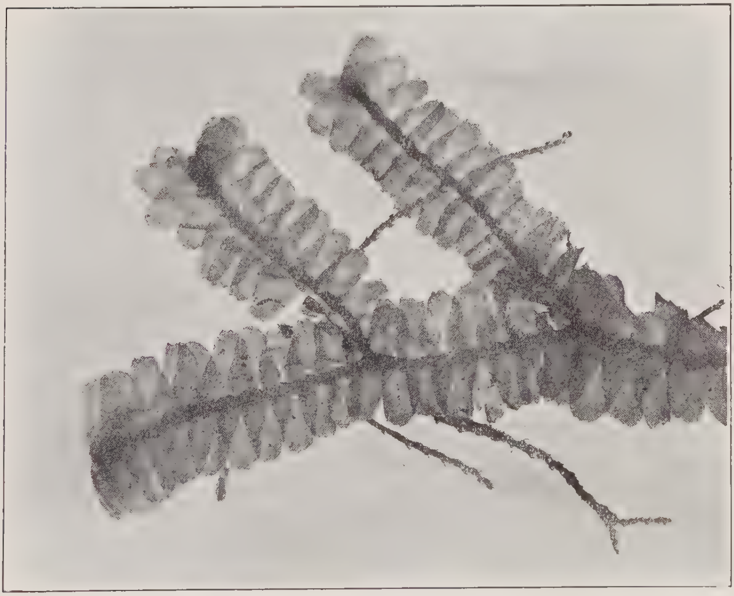

FIGURE 148.

Bazzania trilobata, × 9. Viewed by transmitted light and showing flagella (ventral view).

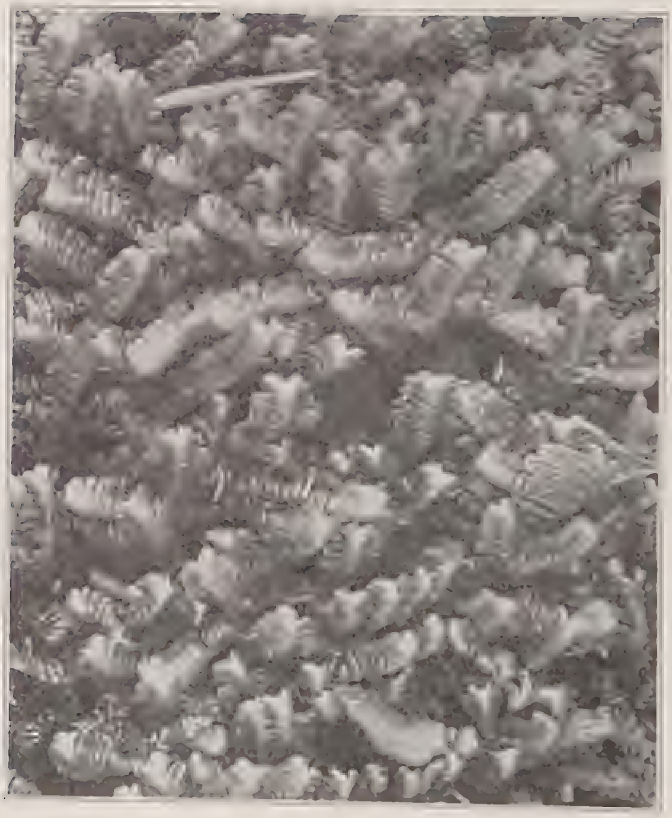

PLATE LXXXI.

Bazzania trilobata, × 5.

B. TRICRENATA (Wahl.) Trevis. (*B. triangularis* (Schleich.) Lindb., *B. deflexa* (Mart.) Underw.), is a subalpine species growing on rocks. The leafy stems are about 1/16 inch wide; the downward-growing flagella are present and most of the leaves are 2- to 3-toothed, although some may be entire. The plants vary a great deal in color from dark to light green. I have seen specimens as dark as the Frullanias.

CEPHALOZIA.

If we include species now commonly referred to Cephaloziella as a separate genus, there are now recognized for our territory more than twenty species of Cephalozia. Most of them are too small to be easily recognized under a hand lens, unless one has already made their acquaintance through the use of higher-powered microscopes, but they are plants of great delicacy, symmetry, and beauty, and they well repay collection and study. They grow on fallen logs, moist banks, sometimes also on exposed soil, and on the borders of Sphagnum swamps. If one takes the trouble to look for them, one or more species may usually be found on every visit to the woods or on every walk along country roads. Ripe capsules, on their long delicate stalks, may be found in May and June. Five of our largest and most common species may perhaps be recognized with a hand-lens by aid of the following key, slightly modified from that used by Evans and Nichols in their paper on "The Bryophytes of Connecticut."

1.	Leaves inflated at the base, the segments ending in long slender points	*C. curvifolia* (plate LXXXII, fig. a).
	Leaves not inflated at the base, the segments acute or acuminate	2.
2.	Leaves not decurrent, symmetrical, the segments straight or scarcely connivent	*C. bicuspidata* (plate LXXXII, fig. b).
	Leaves more or less decurrent, unsymmetrical, the segments more or less connivent	3.
3.	Leaf cells large (mostly 40–80 μ), perianth mouth long-ciliate	*C. connivens* (plate LXXXII, fig. c).
	Leaf cells smaller (mostly 20–40 μ), perianth mouth denticulate or short ciliate	4.

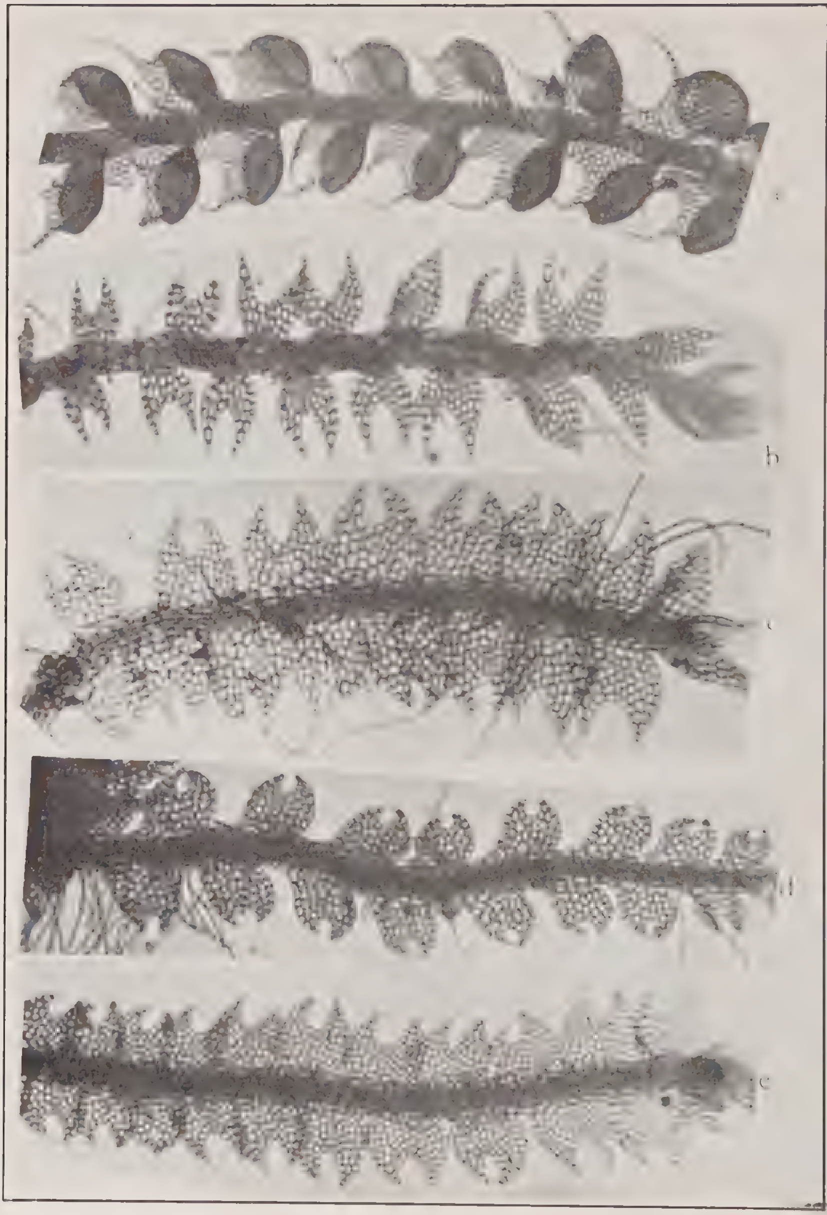

PLATE LXXXII.

(Photomicrographs by Miss Helen E. Greenwood). a, *Cephalozia curvifolia.* b, *C. bicuspidata.* c, *C. connivens.* d, *C. media.* e, *C. catenulata.*

4.	Leaves directed forward, lobed about 1/3 their length, the lobes strongly connivent; leaf cells thin walled; segments of bracts entire or sparingly laciniate	*C. media* (plate LXXXII, fig. d).
	Leaves at nearly right angles to stem, lobed for more than 1/3 their length; leaf cells with uniformly thickened walls; segments of bracts dentate or denticulate.	*C. catenulata* (plate LXXXII, fig. e).

C. CURVIFOLIA (Dicks.) Dum. grows on old logs in the woods throughout the North and East.

C. BICUSPIDATA (L.) Dum. is found on shaded banks and rocks from Greenland to North Carolina and Minnesota and from Alaska to California.

C. CONNIVENS (Dicks.) Lindb. occurs on borders of swamps and in moist places from Prince Edward Island to Ontario and Florida.

C. MEDIA Lindb. (sometimes known as *C. multiflora* and *C. lunulaefolia*) is widely distributed on shaded banks and old logs.

C. CATENULATA (sometimes known as *C. virginiana* and *C. serriflora*) occurs throughout our range, mostly on rotten logs.

CALYPOGÈIA.

C. TRICHOMANIS (L.) Corda, the Common Calypogeia (Kantia of the last edition) is a very common hepatic, forming a light green network or mat on moist soil rich in humus on shaded banks or in the woods. It is medium-sized, the leafy stems being 1/16 inch or more wide, often attenuate and ascending with more minute leaves and ending in a cluster of gemmae. It may be recognized by the following characters: leaves incubous, not complicate-bilobed, entire, roundish-ovate, lying flat in two opposite rows in one plane, underleaves round and close together, bifid

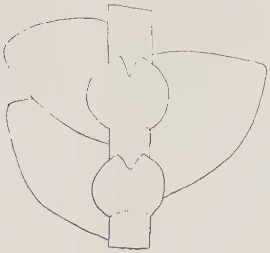

FIGURE 149.

Calypogeia Trichomanis (After Evans). Portion of stem and leaves much enlarged.

one-fourth or less at apex with a shallow, usually rounded sinus; involucre subcylindric, hairy, buried in the substratum and attached to the stem by one side of its mouth; capsule cylindric, the valves spirally twisted. The spores mature in May and June.

C. TENUIS (Aust.) Evans occurs in bogs and is close to *C. Trichomanis*, but may be distinguished according to Evans by its smaller size and more delicate habit, by its variable leaves, showing a strong tendency to be bidentate, or by its deeply bifid ovate underleaves. *C. sphagnicola* (Arn. & Perss.) Warnst. & Loeske also occurs in bogs and perhaps resembles C. TENUIS too much to be safely determined with a hand-lens.

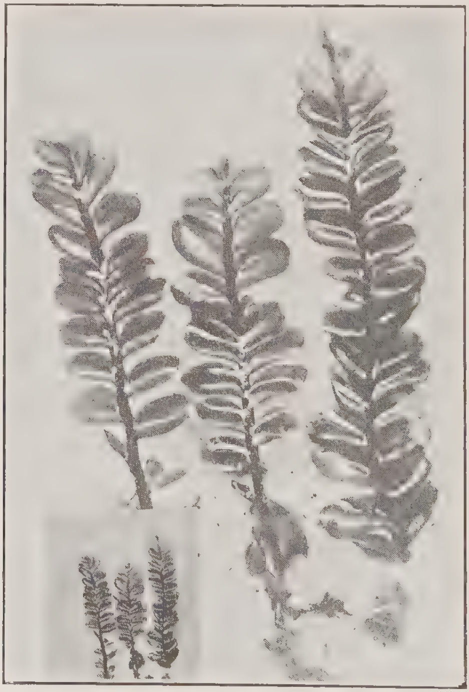

FIGURE 150.
Plagiochila asplenioides. (Insert, × 1).

C. Sullivantii Aust. has leaves that are bidentate at apex and very minute underleaves with their two lobes laterally one-toothed.

C. suecica (Arn. & Perss.) C. Müll. is apparently confined to rotten logs, and differs from *C. Trichomanis* in its small size, variable leaves, deeply bifid underleaves, and other variations that are more microscopic.

One or more other forms or species of Calypogeia, related to *C. Trichomanis* have been reported as occurring within our range.

***LEAVES SUCCUBOUS, TOOTHED OR LOBED.*

PLAGIOCHÌLA.

P. asplenioides (L.) Dum., the Spleenwort Hepatic, is so called because its dark stem and general habit remind one of some of the smaller spleenworts, like the Ebony Spleenwort, for instance. The plants are among the largest of the scale mosses, the stems being 1–4 inches long and 1/8 to 3/16 of an inch wide with the leaves ascending, not closely attached to substratum, rather loose and straggling. Specimens have been found ten inches long. The leaves are succubous, somewhat irregular in shape, but obovate in general outline, not lobed or cleft, but some or all of the leaves are usually denticulate. They are very oblique on the stem, subclasping and somewhat decurrent. There are no underleaves, and as the upper portion of the stem is free from rhizoids, this fact is easily made out. The spores mature in May and June, but perianths can be found in autumn. The "perianth is oblong, narrowed at base, flattened." Common on moist soil and stones in woods, particularly near brooks, strongly resembling some of the creeping stems of some species of Mnium.

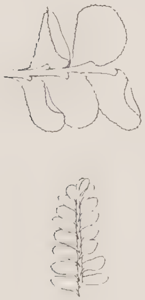

FIGURE 151.

Plagiochila asplenioides. End of branch slightly magnified and portion of underside of branch, × 4.

There is a form of this species rather common in drier places that has the leaves nearly entire and has passed as a different species under the name of *P. porelloides.* This is now considered but a form of *P. asplenioides,* which varies greatly and will be collected for something else several times before the student gets to know it thoroughly.

P. Austini Evans (*P. Sullivantii* Evans, in part) is also found on shaded rocks and on banks of rivulets. Its narrowly ovate leaves have much coarser and usually fewer (mostly 2–6) teeth than those of *P. asplenioides*. In fact, the apex of the leaf may often be described as lobed rather than toothed, the sharp-pointed lobes or teeth often constituting 1/6–1/3 the length of the leaf.

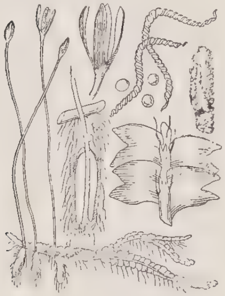

Figure 152.

Geocalyx graveolens: plant, natural size; two pairs of leaves with underleaves; part of stem with an underleaf; section of involucre showing calyptra and base of pedicel; dehiscent capsule, elaters and spores (After Sullivant).

GEÓCALYX.

G. graveolens (Schrad.) Nees is our only species. It has an underground involucre much like that of Calypogeia, which it somewhat resembles in habit and gross appearance, but its leaves are subrectangular and very deeply two-toothed at the ends, as shown in the figure. The underleaves are present, but so small as to be made out with difficulty with a lens. The spores are ripe in May, but the perianths are present in summer.

LOPHOCÒLEA.

The Lophocoleas are very similar in habit and size to Geocalyx, but their underleaves are larger and the perianths are borne on the end of a stem or primary branch. The leafy stems in the species treated are about 1/16 of an inch wide in both genera.

L. heterophylla (Schrad.) Dum., the Variable Lophocolea, is a very common plant, bright green in shaded places, yellowish green when exposed to the sunlight. Like Calypogeia and Geocalyx it is found on rotten logs and on soil, but its ovate to oblong-ovate leaves are not all alike; many of the leaves, especially on young and tender stems, are as deeply two-toothed as in Geocalyx, but with a more rounded notch. On other parts of the same stem some of the leaves are only slightly notched or are entire. This variation of the leaf shapes is so constant as to afford a good means of recognizing the species. The leaves are usually somewhat ascending. The underleaves are deeply cleft, but are too small to study readily with the lens. The species is paroicous. the antheridia being found in the saccate bases of the three to five pairs of bracts below the very young perianth though not often occurring in the highest pair. The perianth is deeply three-lobed and each lobe again lobed and toothed. The capsules are a little longer than broad and mature in May. It is more frequent in the lowlands than at higher altitudes. *L. Austini* Lindb., common at bases of trees about New York City, is probably only a form of *L. heterophylla.*

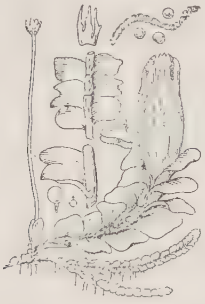

FIGURE 153.

Lophocolea heterophylla: plant, natural size; portion of stem with leaves and perianth; two portions of stem with leaves and underleaves, one showing an antheridium, etc. (After Sullivant).

L. MINOR Nees is more frequent southwards. It is almost sure to be mistaken for Geocalyx when sterile. The underleaves are larger, 2/3 as long as the leaves are wide, and the edges of the leaves frequently bear minute gemmae which make the margin look darker and less distinct. The perianths are situated on the ends of the stems and branches. The perianths are present in November and the spores probably mature in spring. The species occurs on rocks and soil in limestone regions.

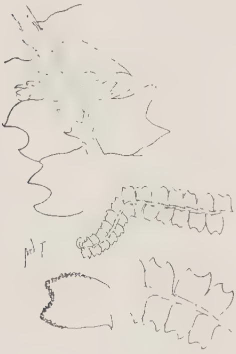

FIGURE 154.

Lophocolea minor. Portion of stem, × 2; another portion, × 4; a portion viewed from the underside, × 16, and a leaf bearing gemmae.

HARPANTHUS SCUTATUS (Web. & Mohr.) Spruce is a third not infrequent species likely to be confused with the preceding, but the plants are so much smaller (scarcely 1/25 of an inch in width), that one who has seen all three will have no difficulty. The leaves are short-ovate, more ascending. The lanceolate-acuminate underleaves are attached to the leaves on one side at their base. The spores mature in May and June. The favorite habitat is old logs in damp places.

Sphenolobus Michauxii (Web.) Steph. is about the size of the preceding, but is a plant of mountainous regions and has a much darker color; the leaves are inserted nearly crosswise of the stem and are almost sheathing at base; when dry they are more or less folded together. The perianth is cylindrical. On rotten wood. There are several plants of the genera Sphenolobus and Lophozia that may be sought here. They are, however, for the most part plants of less frequent occurrence. Many of them are confined to mountainous regions and many can not be well determined with a lens.

LOPHÒZIA.

This genus, which was formerly treated as a subgenus of Jungermannia, consists of numerous species of creeping forms with succubous leaves which are not much longer than broad and are markedly toothed or cleft at the apex. Many are alpine or subalpine.

L. barbata (Schreb.) Dum. is common in the mountains of New England and New York on damp shaded rocks, sometimes on rotten logs or banks. It is rare or entirely lacking in the southern portion of our range. The leafy stems are an inch or more long and about 1/12 inch wide. It usually grows in flat tufts closely applied to the substratum, but occasionally the stems are ascending or erect. The shade of green of the plants depends upon the amount of light they receive; in full sunlight they have a yellowish-brown tinge. The leaves are more or less quadrate in outline and are divided at the apex into three or four teeth or lobes; there are no other teeth or marginal markings. The plants are dioicous and the antheridial plants are slightly different from the spore-producing or female plants as is shown in the figures. Among the plants once known as *Jungermannia barbata*, five species, tolerably distinct, are now currently recognized. The figures given herewith are believed to represent the true *barbata* in the narrower sense. The other four species may be recognized passably well with a hand-lens, at least after one gets fairly well acquainted with them (perhaps with the aid of higher magnifications), but they are, generally speaking, plants of our higher mountains, and are somewhat beyond the scope of the present work.

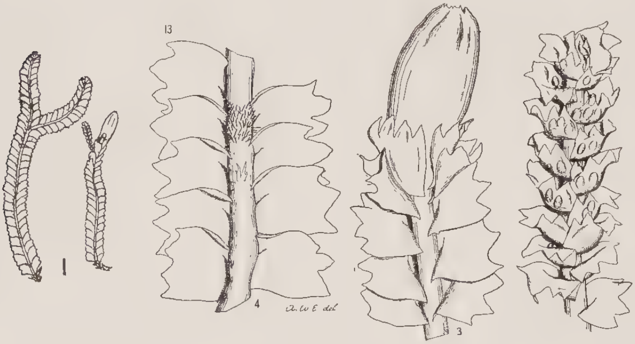

FIGURE 155.

Lophozia barbata (After Evans). 1, Plants, natural size. 3, Female plant from above. 4, Underside of a portion of sterile stem. The figure at the right is an antheridial stem from above.

L. INCISA (Schrad.) Dum. In this plant the leaves are 2–6-lobed, but two of the lobes are larger and the leaf has a tendency to assume the folded form as in Scapania so that many consider the leaves two-lobed with the lobes toothed. The plants are smaller than in *barbata* and usually grow on decaying wood.

Our other species of this genus (except some very rare or alpine forms) have two-lobed or two-toothed leaves and are more likely to be confused with Sphenolobus.

†††*LEAVES SUCCUBOUS, ENTIRE, SCARCELY LONGER THAN BROAD.*

ODONTOSCHÍSMA.

Leafy stems 1/16 inch or less wide, creeping and interwoven, green to red-brown with a trace of green; branches usually rising from the underside of stem; leaves entire, rarely emarginate or bilobed, often bordered. Underleaves invisible with a hand-lens.

The perianth is on a short ventral or lateral branch, which distinguishes all the species from Jamsoniella.

O. PROSTRATUM (Swartz) Trevis. (*O. Sphagni* of many American authors). The plants of this delicate and pretty species grow mostly in swamps over and among mosses and other bog plants, rarely on rotten wood. The stems are creeping with ascending tips; leaves distant to closely imbricate, not becoming minute at base and apex of branches, attached very obliquely, not flattened out but ascending and forming a channel between the two rows, nearly circular to oblong, plainly margined and margin clearly to be seen with high-power lens, outer ends (apices) folding inwards towards each other when dry. Gemmae lacking. This species is found in Massachusetts and southwards.

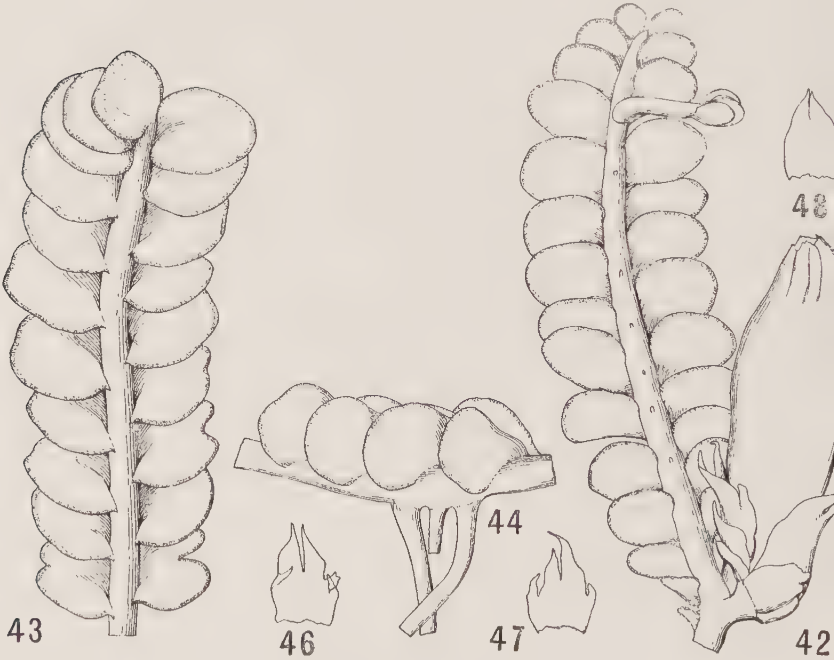

FIGURE 156.

(After Evans). Upper, under, and side view of stem of *Odontoschisma prostratum* and perichaetial bracts, all, × 18. 44 shows ventral flagella.

O. DENUDATUM (Mart.) Dum. grows principally on rotten wood or peaty banks throughout eastern North America. The leaves are not margined and diminish in size towards both ends of the stem or branch; they are more concave than in the preceding, but take the same position when dry. Gemmiparous branches with much diminished leaves are frequent.

JAMSONIÉLLA.

JAMSONIELLA AUTUMNALIS (DC.) Steph. (*Jungermannia Schraderi* Mart.) is a common species often confused with *Odontoschisma prostratum*. It appears to be a plant of more elevated and cooler regions than Odontoschisma, as I find it abundantly in the hills of southern Vermont, but only rarely near New York City. It most frequently grows on decaying wood, but may be found on soil, trunks of trees, etc. It is sometimes plain green, but usually dark green to brownish in the older portions. The leaves are nearly circular to short-oblong, not margined, with the ends reflexed when dry, as shown in the figures. Flagella and gemmae wanting. The perianth is terminal on a leading branch, which distinguishes it from all forms of Odontoschisma when fertile. The position of the leaves when dry easily distinguishes sterile specimens.

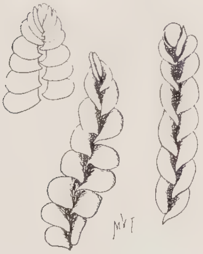

FIGURE 157.

One moist and two dry branches of *Jamsoniella autumnalis*, × 5.

NÁRDIA.

There are several species of this genus within our range, but they are hardly to be made out with a lens except perhaps

N. CRENULATA (Smith) Lindb. It is a smaller plant than the other round-leaved hepatics and grows on soil throughout our range. Mounted and examined with a high power lens it will at once be recognized by the margin, made up of a single row of very large square cells, as shown in the figures. The margin is more distinct than in Odontoschisma and after mounting shows much more clearly. In that genus the margin is made up of two or three rows of much less strongly differentiated cells.

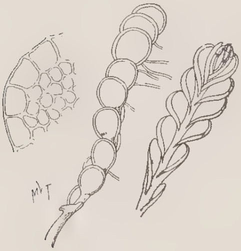

FIGURE 158.

Side and top view of a stem of *Nardia crenulata* enlarged to about 20 diameters, and portion of leaf, × 100.

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††††*LEAVES SUCCUBOUS, ENTIRE, MARKEDLY LONGER THAN BROAD.*

JUNGERMÁNNIA.

J. LANCEOLATA L. (*Liochlaena lanceolata* of many authors) is a common species on rotten logs and banks. The leaves are recurved at apex when dry as in *Jamsoniella*, but the plants are fully twice as wide and the leaves are much longer than broad. Sterile, it may be confused with other forms, but with the pretty puckered perianths present, looking like a full bag tied with a string, there can be no danger of confusing it with anything. The perianths are present and well developed in August; the spores mature in spring.

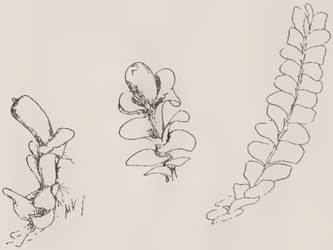

FIGURE 159.

Jungermannia lanceolata; portion of sterile stem, × 2 1/2; and two perianths, × 4.

CHILOSCỲPHUS.

The species of this genus are found on rotten logs, on moist ground among mosses in quiet pools, in running water, or on banks of streams. The terrestrial forms are often somewhat suggestive of *Lophocolea heterophylla* in general habit, but their leaves though often truncate, retuse, or slightly emarginate, are more generally entire than in that species. When fertile they are easily distinguished from any *Lophocolea* by the much shorter perianth-bearing branch, its axis rarely more than 1/25 of an inch long. The species as currently recognized are difficult to define and are not always safely determined with a hand-lens only. *C. rivularis* (Schrad.) Loeske (Fig. 160), found submerged in brooks, is perhaps our commonest form. It is deep-green, often reaches several inches in length, and its leaves are longer than broad. Underleaves are often almost wanting. Perianths are formed on banks, where it becomes more or less exposed to the air.

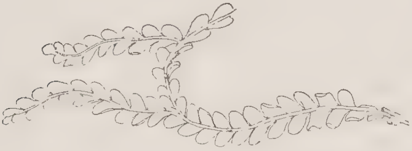

FIGURE 160.

Portion of a stem of *Chiloscyphus rivularis*, natural size.

C. FRAGILIS (Roth) Schiffn. is also aquatic, but its leaves are usually as broad as long and its leaf-cells are larger.

C. PALLESCENS (Ehrh.) Dumort. occurs on old logs or in moist places. It is pale green and its 3-cleft perianth is longer or only a little shorter than the calyptra. It is probably not really distinct from the next.

C. POLYANTHUS (L.) Corda resembles the last mentioned in habit and habitat, but the calyptra finally grows out far beyond the mouth of the perianth. Underleaves are usually well developed.

ILLUSTRATED GLOSSARY OF BRYOLOGICAL TERMS.*

This is not intended to be an exhaustive glossary of botanical terms, but mainly a glossary of those terms which are either confined to bryological works or are used in a somewhat different meaning when applied to mosses. Thus the common terms descriptive of leaves are omitted, except acumen and a few others that are used in a peculiar or unusual way by some authors. Very few terms are here defined that are sufficiently well explained in the common phanerogamic botanies like Gray, Wood, or Britton and Brown.

Braithwaite's "British Moss Flora," Lesquereux and James' "Manual," and Dixon and Jameson's "Handbook of British Mosses" have been largely consulted, and an attempt has been made to determine the meaning of each term according to the usage of all the authors accessible.

For most of the cuts we are indebted to the kindness of Mr. H. N. Dixon, Mr. Jameson, and their publishers, who have very kindly allowed us the use of the cuts in their "Handbook of British Mosses." Terms whose meaning can be made sufficiently clear by definition are not illustrated as a rule.

The figures of hepatics are after those of Evans in the Bryologist.

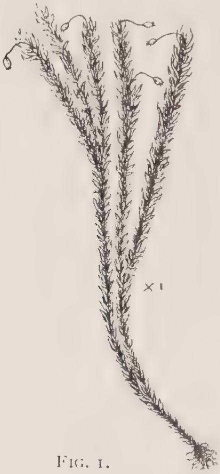

FIG. 1.

Acicular, needle-shaped. Applied to the beak of the operculum.

Acrocarpous, having the sporophyte terminal on a stem or ordinary branch. Acrocarpous mosses can usually be easily distinguished by the erect habit, as shown in the figure. (Fig. 1.) The old sporophyte often seems lateral in acrocarpous mosses, because the stem grows on the next year from a point just below the base of the sporophyte.

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* The figures of the glossary are numbered independently of the rest of the book.

Acumen, the gradually tapering narrow point of an acuminate leaf. (Fig. 2, *b*.)

Acuminate, a term usually applied to leaves that gradually taper to a narrow point. A few recent writers use the term as applying only to those leaves that are not uniformly narrow and limit the term acumen to that part of the apex beyond the point where the narrowing begins to be less abrupt. According to those authors a leaf uniformly narrowed would not be acuminate, no matter how slender the apex. The author has followed this usage to some extent in previous writings, but general usage does not seem to sanction this restriction of the term.

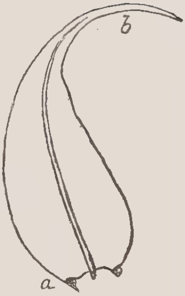

FIG. 2.

Acumination. See *acumen* and *acuminate.*

Acute, with a sharp point, shorter than acuminate.

Aggregate, clustered; usually applied to two or more sporophytes from one perichætium.

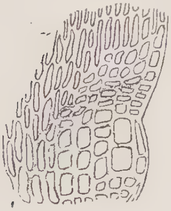

FIG. 3.

Alar cells, the cells at basal angles of the leaf, commonly different from cells of the main part of the leaf, being shorter and often nearly square, or inflated and hyaline, and often highly colored. (Fig. 3.)

Alveolate, honeycombed; with surface markings appearing like the surface of honeycomb.

Amentula, applied to the special antheridia-bearing branches of *Sphagnum*.

Amphigastria, the third row of leaves found on the under side of the stems of the *Hepaticae*. See under *leaves*.

Amphithecium, the outer layers of cells of the sporangium.

Angular cells. See *Alar cells*.

Androgynous, with antheridia and archegonia in the same cluster of leaves; i. e., either synoicous or paroicous.

Annulus, a specialized ring of vesicular cells between the mouth of the capsule and the lid. These cells are often highly elastic and aid in removing the lid when the spores are ripe; they have a peculiar appearance, which is well illustrated in Fig. 4.

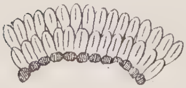

FIG. 4.

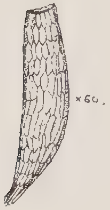

FIG. 5.

Antical, applied to that surface of the stems of hepatics which is uppermost when the stems are prostrate.

Antheridium, the male reproductive organ containing the antherozoids. (Fig. 5.) See Pl. 5, Fig. 7.

Antherozoid, the small flagellate male cell which escapes from the antheridium, and in wet weather swims to the archegonium and down its neck to the egg-cell in the bottom. Pl. 5, Figs. 13–15.

Apical cells, the cells composing the apex of the leaf. They are often broader and shorter than the cells of the middle of the leaf.

Apophysis. See *hypophysis*, the more correct term according to Braithwaite.

Appendiculate cilia, cilia with small transverse spurs attached at intervals along the margin. (Fig. 6.) As these bars sometimes extend inward instead of laterally, they are not always visible in a strictly dorsal view.

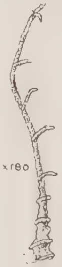

FIG. 6.

Archegonium, the female reproductive organ, enclosing the egg-cell. In the mosses (Fig. 7.) and in the Hepaticæ with the exception of the Anthocerotaceæ, it is more or less flask-shaped. Pl. 5 and Pl. 78.

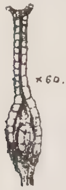

FIG. 7.

Arcuate (capsule), bent in a curve like a bow. (Fig. 8.)

Areolation, the network formed by the outlines of the cells of a leaf.

Articulate (teeth of peristome), marked by crossbars as in Figs. 9 and 34.

Astomous (capsule), without a mouth. Used of capsules which have no regularly dehiscent lid.

Auricles, small lobes at the basal angles of the leaf, usually consisting of cells differing from those of the main part of the leaf in size or shape or both. (Fig. 3 and Fig. 2a.) In certain foliose Hepaticæ, the term is sometimes applied to a saccate lobule of the leaf (Fig. 8a. *Frullania Brittoniæ.*)

Properly used only when there is an outward curve in the outline of the leaf at the base, as in the figures, but often used loosely to denote the basal angles of widely decurrent leaves.

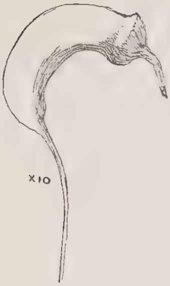

FIG. 8.

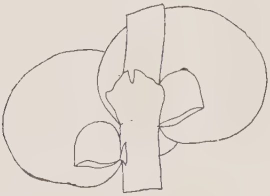

FIG. 8a.

Autoicous or *autœcious*, having male and female organs on the same plant. According to Braithwaite, there are three forms:

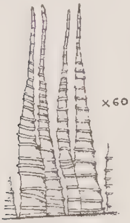

FIG. 9.

1. *Cladautoicous*, with the male organs on a special proper branch.

2. *Gonioautoicous*, with the male organs in a bud-like cluster, and axillary on a female branch.

3. *Rhizautoicous*, male branch very short and cohering to the female by the rhizoids.

Basal or *basilar cells*, cells at the base or insertion of the leaf, often of different shape and color from those of the main part of the leaf.

Beak, prolonged narrow tip of the operculum. The opercula in Figs. 8 and 10 are strongly beaked.

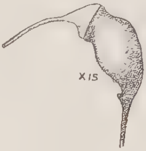

FIG. 10.

Bicostate, having a double costa, which is usually much shorter than in leaves having a single costa.

Bifarious, growing in two ranks.

Bifid, cleft into two divisions like the teeth of Dicranum or the underleaves of Chiloscyphus.

Bi-sexual, synoicous.

Bistratose, of two layers of cells.

Bordered, having a margin different from the rest of the leaf. In Mnium and Bryum the border consists of a few rows of greatly elongated cells, often in two or more layers. (Fig. 11.) In some species of Fissidens (which see) the border is of a different color, but with little difference in cell structure.

Bracts, a term applied to the leaves surrounding the reproductive organs. Those surrounding the antheridia are called perigonial bracts or leaves, and those surrounding the archegonia and base of seta are called perichætial.

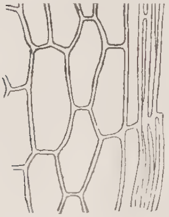

FIG. 11.

In the Hepaticæ, a more or less tubular or sac-like structure known as the perianth is commonly interpolated between the bracts and the archegonia. (Fig. 12, Br.)

Bracteoles, a term applied to underleaves occurring near the reproductive organs in most of the foliose Hepaticæ.

Brood bodies. See *Propagula.*

Bulbil, a minute bulb or bulb-shaped body, usually produced for asexual reproduction.

Cæspitose, forming matted tufts or cushions; e. g., *Leucobryum.*

Calyptra, a thin membrane derived from the wall of a fertilized archegonium. In the mosses (exc. *Sphagnaceæ*) it forms a sort of hood, covering or partially covering the apex of the capsule; (Fig. 13). In the Hepatics it surrounds sessile capsules or sheaths the base of the seta of stalked capsules, in the latter case being itself commonly enclosed in the perianth. (Fig. 12, *Cal.*)

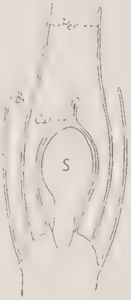

FIG. 12.

Campanulate, bell-shaped.

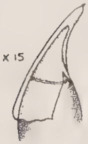

FIG. 13.

Canal, the passage-way from the mouth of an archegonium to the egg, formed by the deliquescence of the cross walls of the single row of axial cells.

Canaliculate, channeled. Applied to leaves with margins incurved, so as to give them a channel-like form; e. g., the upper part of the leaves of *Dicranum fuscescens.* A more complete inrolling until the margins meet would make the leaf tubulose.

Cancellate, latticed. Used of the endostome of the Fontinalaceæ.

Canescent, rather hoary; e. g., *Rhacomitrium canescens.*

Capitulum, a rounded head.

Capsule, the enlarged distal end of the sporophyte; it contains the spores, and is sometimes known as the sporangium. (Figs. 8, 10, 15, 23, and 28.)

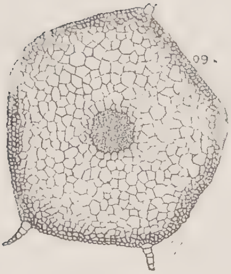

FIG. 14.

Carinate, keeled like a boat; e. g., segments of inner peristome in Fig. 34.

Carpocephalum, discs bearing sporophytes; e. g., Marchantia.

Central strand. The middle of many moss stems is made up of a bundle of much narrower and more slender cells, known as the "central strand." (Fig. 14.) This is usually continuous with the midrib or costa of the leaves, much after the manner of the vascular bundles in the higher plants.

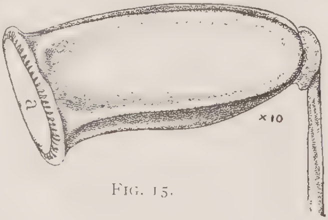

FIG. 15.

Cernuous (capsule), drooping or nodding, somewhat inclined as opposed to erect. (Fig. 15.)

Cilia, hair-like threads of the endostome, alternating with the segments. (Fig. 6, 16c, 34d.)

In the Hepaticæ, often applied to thread-like appendages of a perianth mouth or of leaf-margins.

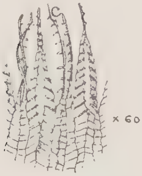

FIG. 16.

Circinate, curved into a circle, resembling Fig. 2, but still more incurved, so that the apex is nearly or quite bent around to the leaf base; e. g., leaves of *Hypnum uncinatum*.

Cirrate or *cirrhate*, applied to leaves which curl up in drying. Cirrate leaves are more regularly curled than crispate leaves.

Cirrhose, having a wavy hair point.

Cladocarpous, having the sporophyte terminating a short special fertile branch; somewhat like half-way between acrocarpous and pleurocarpous; e. g., *Fontinalis*.

Clathrate, resembling lattice-work.

Cleistocarpous, capsule opening irregularly, not by a lid or valves.

Cochleariform, rounded and concave like a spoon or ladle.

Collum, the neck or tapering base of the capsule. (See Fig. 27.)

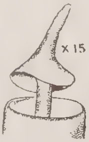

FIG. 17.

Columella, the central axis of the capsule; around it and between it and the outer wall of the capsule are borne the spores. Sometimes the lid adheres to it and is raised upon it, as in Fig. 17.

Coma, *Comal tuft*, a tuft of leaves at the tip of a stem or branch.

Complanate (of leaves or branches), flattened out more or less in one plane.

Complicate, folded together.

Complicate bilobed, in the hepatics as Radula, having leaves two-lobed with one folded over and against the other.

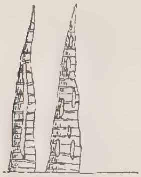

FIG. 18.

Confervoid, formed of fine threads.

Constricted, used of capsules that become narrowed under the mouth when dry. (Fig. 10.)

Contracted. See *constricted*.

Costa, the nerve or midrib of a moss leaf.

Costate, having a costa.

Cribose (peristome teeth), perforated with small apertures. (Fig. 18.)

Crispate or *crisped*, frizzled, curled and twisted in various ways. (Fig. 19.)

Cryptopore (stoma), immersed. See *stoma*.

Cucullate, hood-shaped, the apex curved in like a slipper.

Cucullate calyptra, a calyptra that is hood-shaped and split on one side only. (Fig. 13.)

Cultriform, curved like a short, wide scimitar; e. g., the leaves of *Homalia trichomanoides Jamesii*.

Cygneous (seta), curved suddenly downward, like a swan's neck.

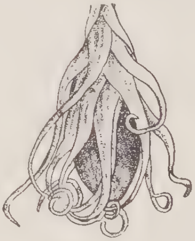

FIG. 19.

Cymbiform, boat-shaped (used by Dixon as a synonym of cucullate); e. g., leaves of *Sphagnum cymbifolium*.

Deoperculate, applied to a capsule after its lid has fallen off.

Dimidiate, split on one side.

Dioicous or *diœcious*, having the male and female organs on separate plants.

Distichous (of leaves), in two opposite rows on the stem.

Divisural line, the line down the teeth of a peristome, through which they split. (The zigzag line down the middle of the teeth and the line down the middle of the segments in Fig. 34.)

Dorsal, belonging to or on the back; i. e., the face of a leaf remote from the stem. Often applied to the Hepaticæ in the sense of *anterior* or *antical*.

Ecostate, lacking a costa.

Egg or *egg-cell*, the female sexual cell or gamete; in the bryophytes, one is formed in the median part of the venter of each archegonium. Pl. 79. Fig 9.

Elater, fine hair-like bodies found among the spores of hepatics, consisting of a single cell with walls spirally thickened. They assist in the dispersal of spores by their hygroscopic movements.

Emergent or *emersed*, half uncovered; of the capsule, when the perichætial leaves reach but do not overtop it.

Endostome. See under *peristome*.

Endothecium, the inner layers of cells of the capsule.

Epiphragm, a membrane covering the mouth of the deoperculate capsule; in Polytrichum and its allies it consists of the dilated top of the columella. (Fig. 15, *a*.)

Equitant, having the leaf-bases conduplicate and sheathing, alternating one above the other on opposite sides of the stem.

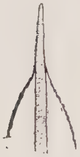

FIG. 20.

Erecto-patent, midway between erect and patent.

Excurrent costa, a costa running out beyond the lamina of a leaf. (Fig. 20.)

Excavate (leaf-insertion), hollowed out in a curve.

Exostome. See under *peristome*.

Exserted, elevated above the surrounding parts; of the capsule, when the perichætial leaves do not reach so high as its base.

Falcate, curved like a sickle. (Fig. 2.)

Fascicle, a bunch or cluster of leaves or branches.

Fasciculate, arranged in bunches.

Fastigiate, of branches, all reaching an equal height. (Fig. 1.)

Fenestrated, perforated.

Flagella, fine string-like branches; e. g., *Dicranum flagellare*.

Flexuose, bent backward and forward, or wavy.

Flowers, often applied to the grouped reproductive organs.

Foot, the basal part of the sporophyte, the part that penetrates the tissues of the gametophyte and through which the young sporophyte draws most of its nourishment.

Fruit, often applied to the sporophyte.

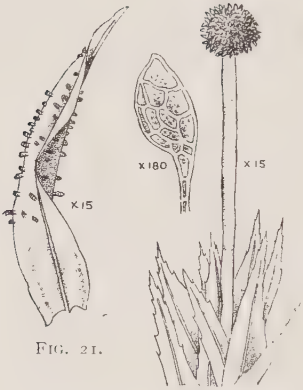

FIG. 21.

Fuscous, dull brown.

Gametophyte, in plants that have an alternation of generations, the phase or generation that bears the gametes or sexual cells. In mosses and hepatics, it constitutes all of what is commonly called "the plant" except the "fruit," or capsule, foot, and seta (if present).

Gemmæ, bud-like bodies, capable of reproducing the plant. Sometimes borne in special heads, sometimes on the surface of the leaves. See *propagula*.

Gemmiferous or *gemmiparous*, bearing gemmæ.

Geniculate (seta), suddenly bent, like a knee.

Gibbous (capsule), more tumid or swollen on one side than on the other. (Fig. 22.)

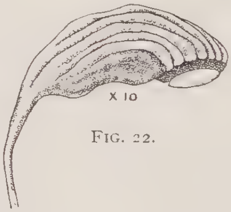

FIG. 22.

Glaucous, originally applied to plants covered with a bluish white bloom, but now applied to mosses that have that color.

Granulose or *granulated*, rough as with minute grains of sand.

Gregarious, growing near together or clustered, but not in close tufts or mats.

FIG. 23.

Guides, a term applied to the large parenchyma cells seen in cross-section of the costa of many Dicrana. See, also, *stereids*.

Gymnostomous, without a peristome.

Heteromallous (leaves or branches), turned in different directions.

Homomallous, turned in the same direction.

Hygroscopic, readily absorbing water and thereby altered in form or direction. *Hygrometric* is sometimes used with a similar meaning.

Hypophysis, a swelling of the seta immediately under the capsule. (Fig. 15.)

Imbricated, closely overlapping each other like the tiles of a roof. (Fig. 23.)

Immersed, covered up; of the capsule when the perichaetial leaves project beyond it.

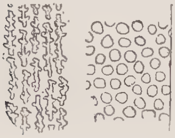

Fig. 24.

Incrassate, of the cell-walls, thickened; of the cells, having thickened walls. (Fig. 24.) Pl. 80, Fig. 2.

Incubous, of the leaves of hepatics, having the upper margin overlapping the lower margin of the leaf next above. (See *Porella* and *Radula*.)

Inflated, applied to the alar cells of leaves when enlarged much beyond the size of the neighboring cells. (Fig. 25.)

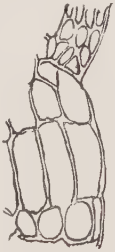

Fig. 25.

Inflorescence, often applied to the clusters of reproductive organs.

Innovations, new growth points, usually occurring just below an arrested stem apex.

Julaceous, smooth, slender and cylindric; like a catkin or a worm.

Lamellæ, thin sheets or plates of tissue; e. g., the plates arising from the costa of the hair-caps and their allies. (Fig. 26.)

Lamellate, having lamellæ.

Lamina, the blade or expanded part of the leaf as distinct from the costa.

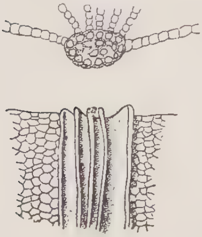

Fig. 26.

Leptodermous, thin-coated; applied to capsules when soft and pliable.

Lid. See *operculum*.

Ligule, a term sometimes applied to the ventral lobe of the leaf in certain hepatics; e. g., *Porella*.

Limb, the upper part of a leaf as distinct from the leaf base.

Limbate leaf, a leaf bordered by a part of another color; e. g., many species of Fissidens, which see.

Lobe, the upper and usually larger lobe of the complicate-bilobed leaves of hepatics.

Lobule, the under and usually smaller lobe of the complicate-bilobed leaves of hepatics. (See *Radula*.)

Mammillate or *mammillar* (lid of the capsule), convex with a short projection in the center. (Fig. 27.)

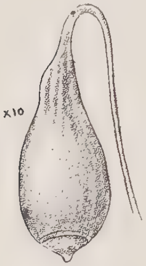

Fig. 27.

Margined. See *bordered.*

Median leaf-cells, those from the middle of the leaf.

Mitriform (calyptra), cleft on two or more sides, and symmetrical. (Pl. 27, Fig. 14.)

Monoicous or *monœcious*, having male and female organs on the same plant but separate.

Muricate, muriculate (spore), rough with minute sharp points.

Muticous, not pointed.

Neck (of the capsule), the lowest part just above the point where it joins the seta. See, also, *collum*. The slender upper part of an archegonium.

Nerve. See *costa.*

Nodose, covered with knots or prominences.

Nodulose, covered with very small knots or prominences (the cilia in Fig. 34).

Ochrea, a thin sheath around the base of the seta, terminating the vaginula.

Oösphere, the egg-cell or ovum found in the base of the archegonium. (Pl. 78, Fig. 9.) After fertilization, by union with the antherozoid, it develops into the sporophyte.

Operculum, the lid which closes the capsule and, falling, permits the spores to escape. (Figs. 10 and 17.)

Fig. 28.

Fig. 29.

Pachydermous, thick-skinned; applied to the walls of capsules or to cells when firm and resisting.

Panduriform (of leaves), fiddle-shaped.

Papillæ, minute, rounded or acute protuberances.

Papillose, rough with papillæ, rough with small rounded or acute protuberances. (Fig. 28.)

Paraphyllia, minute leaf-like or much-branched organs among the leaves. (Fig. 29.) E. g., *Thuidium*.

Paraphyses, jointed hyaline hairs growing among the reproductive organs. (Fig. 30.)

Parenchymatous, cells with broad ends abutting on each other, not dovetailing into each other. (The large cells in Fig. 11.)

Paroicous, having its male and female organs in the same cluster, but not mixed, the antheridia being in the axils of the perichætial bracts below the archegonia. (Fig. 31.)

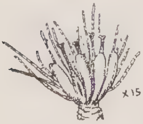

FIG. 30.

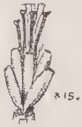

FIG. 31.

Patent, spreading at an angle of 26°–45° (Braithwaite); spreading at an angle of 45° or more (Dixon).

Patulous, more widely spreading than *patent*.

Pedicel. See *seta*.

Pendulous, somewhat hanging or drooping; more so than in *cernuous*. (Fig. 27.)

Percurrent costa, reaching to the apex of the leaf, but not beyond.

Perianth, the tubular or sac-like structure that surrounds the young sporophyte or later the base of the seta in the foliose hepatics. (Fig. 32.) It is supposed to represent a coalescence of leaf-like organs. See *perigynium*. (Fig. 12 Per.)

Perichætial. See *bracts*.

Perigonial. See *bracts*.

Perigynium, a tubular or sac-like structure that surrounds the young sporophyte or later the base of the seta in a few genera of the foliose hepatics. It represents a hollowed-out development of the stem rather than the coalescence of leaf-like organs. (Fig. 33c.) See *perianth*.

Peristome, the fringe surrounding the mouth of the capsule upon removing the lid. This fringe may consist of a single row of processes, known as *teeth*, as in Fig. 9, or of a double row as in

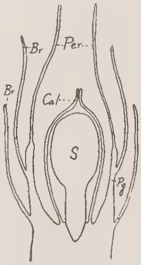

FIG. 32. *Lophocolea*.

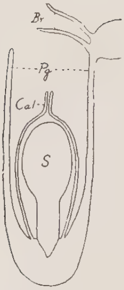

Fig. 33.

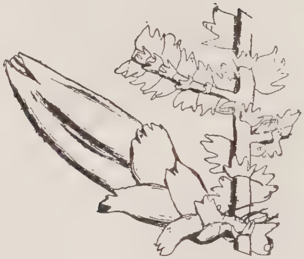

Fig. 33d. *Lepidozia reptans.*

Fig. 34. In the latter case the entire fringe is still the *peristome*, but the term is also applied in a particular sense to the outer row; the outer row is often spoken of as the *exostome* (*b*), and the inner as the *endostome* (*c*). The inner row consists of as many projections as the outer, but alternating with them; these are known as *processes* or *segments* (*c*). Between the segments there are often one or more slender hair-like processes known as *cilia*. (Fig. 34, *d;* Fig. 16, *c*.)

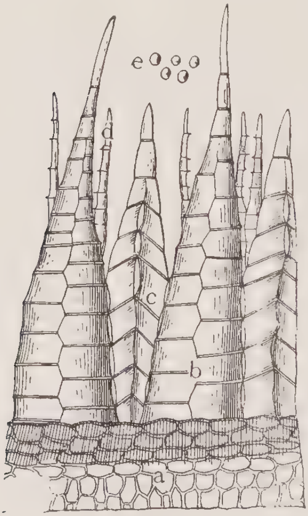

Fig. 34.

Moss peristomes, viewed with a compound microscope, are among the most beautiful of natural objects. They are not composed of cells (except in the Polytrichaceæ and a few other small families), but of thickened cell-walls. The cross markings on the teeth, segments and cilia are the lines of junction of the transverse cell-walls with the longitudinal cell-walls forming the peristome. The radial walls are rarely thickened so

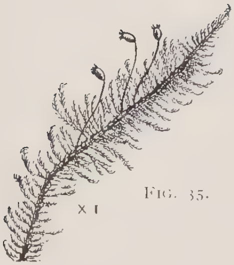

FIG. 35.

as to appear in any way; the divisural line shows the place of their attachment to the teeth and segments.

The researches of Philibert have shown that the endostome, not the exostome, corresponds to the peristome of the mosses, having a single row of teeth.

Phaneropore (stoma), superficial. See *stomata.*

Pinnate, having numerous equidistant spreading branches on each side like a feather. (Fig. 35.)

Pitted cell-walls, those marked with small apertures or depressions; e. g., the cell-walls of the leaves of *Dicranum scoparium* and other species. (Fig. 36.)

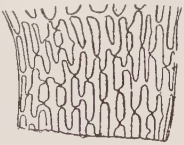

FIG. 36.

Pleurocarpous, having the sporophyte lateral on a short lateral special branch. (Fig. 35 and p. 162, Fig. 72, 1b.) Pleurocarpous mosses can usually be recognized by the creeping habit.

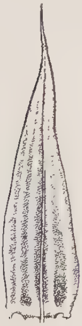

FIG. 38

Plicate, folded in pleats or furrows; e. g., leaves of Camptothecium. (Fig. 38.)

Plicæ, folds of a plicate leaf.

Plumose, feathery.

Pluriseriate, many-ranked; i. e., as applied to leaves arranged in several rows along the stem.

Polygamous, with antheridia and archegonia disposed in various ways on the same plant.

Porose. See *pitted.*

Postical, used as the opposite of antical for that surface of the stems of hepatics to which the underleaves are attached, the under or posterior face.

Primordial utricle, "the first layer deposited within a cell." As applied to the cells of the moss leaf it refers to the layer of protoplasm lying next the cell-wall, which often is very conspicuous when dried and shrunken away from the cell-wall. As a character for use in the identification of species it is valueless, because its appearance is due to circumstances not well understood, and is frequently present in some specimens and lacking in others of the same species.

Processes. See under *peristome.*

Proliferous, bearing young shoots from the antheridial or archegonial cluster of leaves.

Propagula or *brood bodies*, small cellular bodies produced on various parts of the plant for asexual reproduction. (Fig. 21.) According to Dr. Best the term gemmæ should be restricted to bud-like bodies.

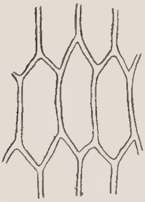

Fig. 39.

Prosenchymatous (cells), with pointed ends dovetailing into each other. (Fig. 39.)

Protonema, the green, branched, alga-like threads produced from the spore and often persistent during the lifetime of the plant produced from it. Protonema and radicles differ chiefly in the presence or absence of chlorophyll, and either may develop the other. (Fig. 40.)

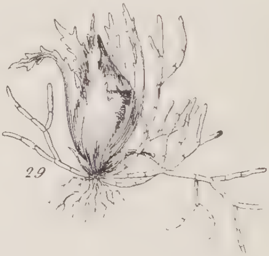

Fig. 40.

Pseudopodium, a leafless branch resembling a seta and often bearing gemmæ. (Fig. 21.) Of sphagnum, the stalk (false seta) bearing the capsule.

Pulvinate, like a cushion.

Quadrate (cells), square or nearly so. (Fig. 3.)

Radicles, rootlets springing from the sides and base of the stem. See also *protonema.*

Ramuli, minute branchlets.

Rhizoid. See *radicles.*

Rostellate (operculum), with a short beak.

Rostrate (operculum), with a long beak. (Figs. 8 and 10.)

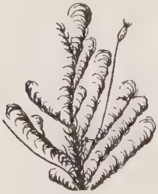

Fig. 41.

Rosulate, in the form of a rosette.

Rough. Same as *papillose.*

Rugose, wrinkled (in the case of leaves it is usually applied to transverse wrinkles); e. g., leaves of *Hypnum rugosum.*

Scabrose. Same as *papillose.*

Secund, twisted or turned to one side. (Fig. 41); e. g., leaves of many Hypnums. Not necessarily curved as in the figure.

Segments. See under *peristome.*

Seta, the stalk on which the capsule is borne. (Figs. 8, 15, and 27.)

Sigmoid, curved like the letter S.

Spermatozoid. See *antherozoid.*

Sporangium, often applied to the capsule, but by some authors restricted to the spore sac, or inner sac of the capsule containing the spores.

Spores, small round bodies contained in the capsule, serving the purpose of seeds, but in no way homologous with them. (Fig. 34, *e*).

Sporophyte, or *sporophore*, in plants that have an alternation of generations, the phase or generation that bears the spores, that results from a fertilized egg. In mosses and hepatics, it consists of capsule, foot, and usually a seta, and constitutes the so-called "fruit," the spore-bearing part or generation.

Sporogonium, the sporophyte, especially when spoken of without reference to its antithesis to the gametophyte.

Stegocarpous, having the capsule operculate.

Stereids, the small thick-walled cells seen in cross-section of the costa of some mosses, especially *Dicranum*.

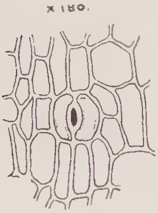

FIG. 42.

Stipitate, having a short stem. Applied to antheridia and archegonia.

Stoloniferous stem, a slender creeping stem with minute leaves.

Stomata, pores in the walls of capsules, surrounded by special guard-cells and serving the same purpose as the stomata in the epidermis of the leaves of the flowering plants. They may be superficial, as in Fig. 42, or immersed; i. e., sunken and nearly covered with other cells, as in Fig. 43.

Striate, marked with striæ or slight furrows.

Struma, a goiter-like swelling on one side at the base of the capsule. (Fig. 10.)

Strumose, having a struma.

Substratum, the material upon which the plant grows.

Sulcate, deeply furrowed with longitudinal channels. As applied to leaves, both *striate* and *sulcate* really refer to the fold whose concave surface is on the inner or ventral surface of the leaf. Of the capsule, deeply furrowed. (Fig. 22.)

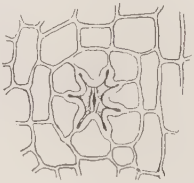

FIG. 43.

Sulcus, a furrow or groove, used especially in reference to the median furrow of the dorsal surface of the thallus in the Ricciaceæ and Marchantiaceæ.

Synoicous or *synœcious*, having the male and the female organs mixed together in the same cluster. (Fig. 30.)

Systilius, the lid continuing fixed to the columella, and thus elevated above the capsule when dry. (Fig. 17.)

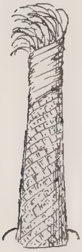

FIG. 44.

Tessellate, checkered in little squares; applied particularly to the peristomes of some of the Tortulaceæ. (Fig. 44.)

Thallus, a broad, flattened plant form taking the place of both stem and leaves on many of the lower plants. (See Marchantia.)

Tomentose, covered with a thick felt of radicles.

Tooth. See under *peristome*.

Trabeculate (peristome teeth), with prominent transverse bars. (Fig. 9.)

Trigone, a triangular thickening of the walls where three cell-angles meet. (Pl. 80, Fig. 6.)

Tubulose. See *canaliculate*.

Tumid, *turgid*, appearing as if swollen from pressure within.

Turbinate, top-shaped; e. g., capsule of *Bryum turbinatum*.

Twisted (seta). The seta of many mosses twists strongly in drying. If the twist is such as would be made by seizing the capsule and twisting it to the right, it is said to be twisted to the right. It is probable that this twisting of the seta aids in scattering the spores.

Umbonate, round with a projecting point in the center.

Uncinate, hooked, curved back at point. (Fig. 41.)

Underleaves, leaves found on the under side of the stem of many of the leafy Hepaticæ and constituting a "third row." They are commonly smaller than the other leaves and different in form. (Fig. 44b and p. 293, Fig. 149.)

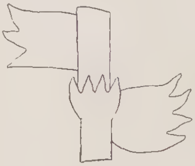

FIG. 44b. *Lepidozia.*

Undulate, with an alternately concave and convex margin, wavy; e. g., leaves of *Dicranum undulatum*.

Urceolate, shaped like an urn or pitcher.

Vaginula, the cellular sheath surrounding the base of the seta, originally the lower part of the archegonium.

Valves, the parts of the capsule wall remaining after its vertical or longitudinal dehiscence in most of the Hepaticæ and in the Andreæaceæ.

Veil, the calyptra.

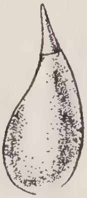

FIG. 45.

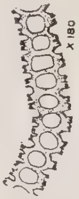

FIG. 46.

Ventral, often applied to the Hepaticæ in the sense of *posterior* or *postical*.

Ventral surface, the surface of a leaf next the stem.

Ventricose, bulging on one side. (Fig. 45.)

Vermicular, narrow and curved like a little worm; applied to leaf-cells.

Verruculose or *verrucose*, covered with wart-like prominences. (Fig. 46.)

Vesicular, inflated like a bladder.

Wavy. See *undulaie*. a

A NUMBERED LIST OF THE MOSSES DESCRIBED IN THE PRECEDING PAGES SYSTEMATICALLY ARRANGED.*

		PAGE
	SPHAGNACEAE	28
1	Sphágnum capilláceum (Weiss) Schrank	32, 36
2	S. Girgensòhnii Russow	36
3	S. palústre (L.) Hedw.	36
4	S. papillòsum Lindb.	33
5	S. squarròsum Pers.	32, 34, 36
	ANDREAEACEAE	37
6	Andreaea petróphila Ehrh.	37
7	A. Róthii W. & M.	37
	GEORGIACEAE	38
8	Geórgia Brównii (Dicks.) C. M.	40
9	G. pellùcida (L.) Rabenh.	38
	POLYTRICHACEAE	40
10	Catharínea angustàta Brid.	55
11	C. críspa James	55
12	C. undulàta (L.) W. & M.	52
13	Pogonàtum alpìnum (L.) Roehl	50, 51
14	P. brachyphýllum (Mx.) Beauv.	49, 50, 51
15	P. brevicaùle (Brid.) Beauv.	49, 50
*16	P. capillàre (Mx.) Brid.	52
17	P. urnígerum (L.) Beauv.	51, 52
18	Polýtrichum commùne L.	43, 44, 48
*19	P. grácile Dicks.	45
20	P. junipérinum Willd.	45, 46
21	P. ohioénse R. & C.	23, 44, 45
22	P. pilíferum Schreb.	45, 47, 48
*23	P. stríctum Banks	47
	BUXBAUMIACEAE	56
24	Buxbaùmia aphýlla L.	56
25	B. indusiàta Brid.	57
26	Wébera séssilis (Schmid.) Lindb. (*Diphyscium foliosum*).	57, 58
	FISSIDENTACEAE	59
27	Físsidens adiantoìdes (L.) Hedw.	60 62

---

* Species marked * are not illustrated.

PAGE
*28 F. cristàtus Wils. 60
29 F. Juliànus (Savi.) Schimp. 62
30 F. osmundioìdes (Swtz.) Hedw. 60
31 F. taxifólius (L.) Hedw. 60, 62
DICRANACEAE 62
32 Brùchia Sullivántii Aust. 65, 66
33 Cerátodon purpùreus (L.) Brid. 26, 70, 72, 73
34 Dicranélla cerviculàta (Hedw.) Schimp. 76
35 D. heteromálla (L.) Schimp. 74
36 D. rufèscens (Dicks.) Schimp. 77
37 D. vària (Hedw.) Schimp. 77
*38 Dicranodóntium longiróstre 83
39 Dicrànum Drummóndii C. M. 80, 82
40 D. flagellàre Hedw. 83
41 D. fúlvum Hook. 83
42 D. fuscéscens Turn. 79, 80
43 D. longifòlium Ehrh. 80, 84
44 D. scopàrium (L.) Hedw. 79
45 D. undulàtum Ehrh. 80, 82
46 Dítrichum pállidum (Schreb.) Hampe 69
(*Leptotrichum pallidum*).
47 D. tórtile (Schrad.) Hampe 67, 68
(*L. tortile*).
48 D. váginans (Sulliv.) Hampe 67, 68
(*L. vaginans*).
49 Leucobrỳum glaùcum (L.) Schimp. 85, 86
50 Oncóphorus Wahlenbérgii Brid. 70
51 Pleurídium alternifòlium. 66
52 P. subulàtum (L.) Rabenh. 64
53 Trematódon ambíguus (Hedw.) Hornsch. 73
*54 T. longicóllis Mx. 73
GRIMMIACEAE 87
55 Grímmia apocárpa (L.) Hedw. 92
56 G. Ólneyi Sulliv. 94
57 G. pennsylvánica Schwaegr. 94
58 Hedwígia álbicans (Web.) Lindb. 88
59 Ptychomítrium incúrvum (Schwaegr.) Sulliv. 89, 90
60 Rhacomítrium aciculàre (L.) Brid. 97
61 R. fasciculàre (Schrad.) Brid. 99

---

* Species marked * are not illustrated.

PAGE
62 R. microcárpum (Schrad.) Brid. 99, 100
TORTULACEAE 100
63 Ástomum Sullivántii Schimp. 67
64 Bárbula convolùta Hedw. 105, 107
65 B. unguiculàta (Huds.) Hedw. 105, 106
*66 Desmátodon plinthòbius Sulliv. & Lesq. 112
*67 Didỳmodon rubèllus (Hoffm.) B. & S. 69
68 Gymnóstomum curviróstre (Ehrh.) Hedw. 101, 102, 104
*69 G. rupéstre Schleich 103
70 Póttia truncátula (L.) Lindb. 134
*71 Tortélla caespitòsa (Schwaegr.) Limpr. 108
72 T. tortuòsa (L.) Limpr. 108
73 Tórtula muràlis (L.) Hedw. 111
74 T. ruràlis (L.) Ehrh. 112
*75 T. ruralifórmis (Besch.) Dixon 112
76 Weìsia virídula (L.) Hedw. 103, 104
ENCALYPTACEAE 114
77 Encalýpta ciliàta (Hedw.) Hoffm. 115, 116
78 E. streptocárpa Hedw. 114
ORTHOTRICHACEAE 116
79 Drummóndia clavellàta Hook. 116
80 Orthótrichum anómalum Hedw. 120
*81 O. obtusifòlium Schrad. 120
82 O. ohioénse S. & L. 123
83 O. sordídum S. & L. 123, 124
84 O. speciòsum Nees 123
85 O. strangulàtum Sulliv. 123, 125
*86 Ulòta Americàna (Beauv.) Lind. 119
(*U. Hutchinsiae*).
87 U. críspa Brid. 117, 119
88 U. Ludwígii Brid. 117, 119
SCHISTOSTEGACEAE 126
89 Schistóstega osmundàcea (Dicks.) Mohr. 126
SPLACHNACEAE 128
90 Spláchnum ampullàceum L. 128
FUNARIACEAE 129
*91 Funària flávicans Mx. 131
92 F. hygrométrica (L.) Sibth 129, 130, 131, 132
93 Physcomítrium turbinàtum (Mx.) Brid. 132

---

* Species marked * are not illustrated.

		PAGE
	AULACOMNIACEAE	135
94	Aulacómnium heteróstichum (Hedw.) B. & S.	137
95	A. palústre Schwaegr.	73, 135
	BARTRAMIACEAE	137
96	Bartrámia Òederi (Gunn.) Swartz	139
97	B. pomifórmis (L.) Hedw.	137, 138
98	Philonòtis fontàna (L.) Brid.	139, 140
	BRYACEAE	141
99	Brỳum argénteum L.	141, 142
*100	B. bìmum Schreb.	145
101	B. caespitícium L.	143, 145, 146
102	B. Duválii Voit.	147
103	B. ròseum (Weis.) Schreb.	142, 144
104	Leptobrỳum pyrifórme (L.) Wils.	150
105	Mnìum affìne Bland.	152, 154
*106	M. cinclidioìdes (Blytt) Hueben.	157
107	M. cuspidàtum (L.) Leyss.	151, 152, 155
*108	M. Drummóndii B. & S.	154
109	M. hórnum L.	154, 156, 159
110	M. punctàtum L.	156, 158, 159
*111	M. rostràtum Schrad.	156
112	M. spinulòsum B. & S.	153, 154, 159
*113	M. stellàre Reich.	157
114	Pòhlia elongàta Hedw.	149, 150
115	P. Lescuriàna (Sulliv.) Grout	147, 149
116	P. nùtans (Schreb.) Lindb.	147, 148
	PLEUROCARPI	160
	LESKEACEAE	160
117	Anómodon apiculàtus B. & S.	161
118	A. attenuàtus (Schreb.) Hueben.	161
*119	A. mìnor (P. Beauv.) Fuern.	160, 161
120	A. rostràtus (Hedw.) Schimp.	162
*121	Thèlia asprélla (Schimp.) Sulliv.	164
122	T. hirtélla (Hedw.) Sulliv.	163
*123	T. Lescùrii Sulliv.	164
124	Thuídium abietìnum (L.) B. & S.	164, 166
125	T. delicátulum (L.) Mitt.	164, 166
126	T. recógnitum (Hedw.) Lindb.	166, 167
127	T. scìtum (Beauv.) Aust.	164, 166

---

* Species marked * are not illustrated.

PAGE
HYPNACEAE 170
*128 Amblystègium adnàtum (Hedw.) J. & S. 181
*129 A. irríguum (Hook. & Wils.) B. & S. 197
130 A. sérpens (L.) B. & S. 194, 195
131 Brachythècium acuminàtum (Hedw.) Kindb. 210, 211
*132 B. oxyclàdon (Brid.) J. & S. 184
133 B. plumòsum (Sw.) B. & S. 199, 200
134 B. popùleum (Hedw.) B. & S. 200
135 B. rivulàre B. & S. 198
136 B. salebròsum (Hoffm.) B. & S. 201, 202
137 B. velutínum (L.) B. & S. 201, 202
†138 Callìergon Schréberi (Willd.) Grout 185, 186
†139 Campylium chrysophýllum (Brid.) Bryhn 187, 191
140 Cirriphýllum Bóscii (Brid.) Grout 204
141 Climàcium americànum Brid. 213
142 C. dendroìdes (L.) Web. & Mohr. 213
143 C. Kindbérgii (R. & C.) Grout 213
144 Éntodon cladorrhìzans (Hedw.) C. Muell 209, 210, 211
145 E. sedúctrix (Hedw.) C. Muell. 207, 210
146 Eurhýnchium hìans (Hedw.) J. & S. 202
147 E. strigòsum robústum Roell 203
‡148 E. ruscifórme (Neck.) Milde 196
‡149 E. serrulàtum (Hedw.) Kindb 203
150 Hylocòmium prolíferum (L.) Lindb. 168
151 H. rugòsum (Ehrh.) DeNot 186, 187, 188
152 H. triquétrum (L.) B. & S. 186, 189, 190
153 H. Crista-castrénsis L. 172, 174, 175, 176
154 H. curvifòlium Hedw. 178
155 H. dilatàtum Wils 196
156 H. Haldaniànum Grev. 181, 183, 184
157 H. impònens Hedw. 174, 177
158 H. Patiéntiae Lindb. 179
159 H. recúrvans (Mx.) Schwaegr. 181, 182
160 H. réptile Mx. 179, 180, 181
161 H. uncinàtum Hedw. 192
162 Plagiothècium denticulàtum (L.) B. & S. 207
163 P. striatéllum (Brid.) Lindb. 190, 191

---

*Species marked * are not illustrated.

† Hypnum of earlier editions.

‡ Rhynchostegium of previous editions.

PAGE
164 P. sylváticum (Huds.) B. & S. 206, 207
165 Pylaísia Schìmperi R. & C. 207, 208
Rhynchostegium rusciforme (Neck.) B. & S. See Eurhynchium.
FABRONIACEAE 213
166 Anacámptodon splachnoìdes (Froelich) Brid. 213, 214
LEUCODONTACEAE 214
167 Leùcodon bráchypus Brid. 215, 216
168 L. julàceus (Hedw.) Sulliv. 215
*169 L. sciuroìdes (L.) Schwaegr. 215
NECKERACEAE 216
170 Homàlia trichomanoìdes Jamesii (Schimp.) Holz. 219, 220
171 Néckera pennàta (L.) Hedw. 216, 217, 218
FONTINALACEAE 219
172 Dichelỳma capillàceum (Dill.) B. & S. 221, 222
173 Fontinàlis dalecárlica B. & S. 223, 224
174 F. gigántea Sulliv. 223, 224
175 F. Nòvae-Angliae Sulliv 223, 225

HEPATICAE.

RICCIACEAE 227
*1 Ríccia arvénsis Aust. 232
*2 R. Aústini Steph. 230
3 R. Beyrichiàna Hampe 232
*4 R. crystallìna L. 230
*5 R. dictyóspora M. A. Howe 232
6 R. flùitans L. 229
7 R. hírta Aust. 232
8 R. sorocàrpa Bisch. 231
*9 R. Sullivántii Aust. 230
10 Ricciocárpus nàtans (L.) Corda 233
MARCHANTIACEAE 235
11 Asterélla tenélla (L.) Beauv. 253
12 Conocéphalum cónicum (L.) Dum 251, 252
13 Grimáldia fràgrans (Balb.) Corda 255
14 Lunulària cruciàta (L.) Dum. 253
15 Marchántia polymórpha L. 235, 250

---

* Species marked * are not illustrated.

PAGE
16 Preìssia quadràta (Scop.) Nees 254
17 Reboùlia hemisphaèrica (L.) Raddi 256
ANTHOCEROTACEAE 257
18 Anthóceros caroliniànus Michx. 257
19 A. críspulus (Mont.) Douin 258
*20 A. laèvis L. 258
*21 A. Macoúnii M. A. Howe 259
22 A. punctàtus L. 258
23 Notothỳlas orbiculàris (Schwein.) Sulliv. 259
METZGERIACEAE 259
24 Blàsia pusílla L. 262
25 Fossombrònia pusílla Dum. 266
*26 Metzgèria conjugàta Lindb. 260
*27 M. crassifòlia Lindb. 261
*28 M. furcàta (L.) Dum. 261
29 M. pubéscens (Schrank) Raddi 261
30 Pallavicínia Flotòwiana (Nees.) Lindb. 261
31 P. Lyéllii (Hook) S. F. Gray 261
32 Péllia epiphýlla (L.) Corda 263
33 P. Fabroniàna Raddi 264
*34 P. Neesiàna (Gottsche) Limpr. 264
35 Riccárdia làtifrons Lindb. 265
*36 R. multífida (L.) S. F. Gray 265
37 R. pínguis (L.) S. F. Gray 266
JUNGERMANNIACEAE 267, 273
*38 Bazzània tricrenàta (Wahl.) Trevis 291
(*B. deflexa*).
39 B. trilobàta (L.) S. F. Gray 288, 290
40 Blepharóstoma trichophýllum (L.) Dum. 286
*41 Calypogèia suécica (Arn. & Perss.) C. Muell. 295
*42 C. Sullivántii Aust. 295
*43 C. ténuis (Aust.) Evans 294
*44 C. trichòmanis (L.) Corda 293
45 Cephalòzia bicuspidàta (L.) Dum. 293
46 C. catenulàta 293
47 C. connìvens (Dicks.) Lindb 293
48 C. curvifòlia (Dicks.) Dum. 293
49 C. mèdia Lindb. 293
*50 Chiloscỳphus frágilis (Roth) Schiffn. 303

---

* Species marked * are not illustrated.

		PAGE
*51	C. palléscens (Ehrh.) Dum.	303
*52	C. polyánthus (L.) Corda	303
53	C. rivulàris (Schrad.) Loeske	303
*54	Cololejeùnea Biddlecòmiae (Aust.) Evans	280
55	Diplophyllèia apiculàta Evans	284
*56	D. taxifòlia (Wahl.) Trevis	284
57	Frullània Asagrayàna Mont.	276
58	F. eboracénsis Gottsche	275
*59	F. Tamarísci (L.) Dum.	277
60	Geócalyx gravèolens (Schrad.) Nees	296
*61	Harpánthus scutàtus (Web. & Mohr) Spruce	297
62	Jamsoniélla autumnàlis (DC.) Steph.	301
63	Jubula pennsylvánica (Steph) Evans	278
64	Jungermánnia lanceolàta L.	302
	Kantia Trichomanis (L.) S. F. Gray (Calypogeia)	293
65	Lejeùnea cavifòlia (Ehrh.) Lindb.	279
66	Leucolejeùnea clypeàta (Schwein.) Evans	280
67	Lepidòzia réptans (L.) Dum.	287
*68	L. setàcea (Web.) Mitt.	288
*69	L. sylvática Evans	288
70	Lophocòlea heterophýlla (Schrad.) Dum.	296, 303
71	L. mìnor Nees	297
72	Lophòzia barbàta (Schreb.) Dum.	298
*73	L. incìsa (Schrad.) Dum.	299
74	Nárdia crenulàta (Smith) Lindb.	302
*75	Odontoschísma denudàtum (Mart.) Dum.	301
76	O. prostràtum (Swartz) Trevis	300
77	Plagiochila asplenioìdes (L.) Dum	295
*78	P. Aústinii Evans	296
79	Porélla pinnàta L.	278
*80	P. platyphýlla (L.) Lindb.	278
81	P. platyphylloìdea (Schwein.) Lindb	268, 269, 278
*82	Ptilídium ciliàre (L.) Nees	285
83	P. pulchérrimum (Web.) Hampe	286, 287
84	Rádula complanàta (L.) Dum.	281
85	Scapània nemoròsa (L.) Dum.	282
86	S. undulàta (L.) Dum.	283
*87	Sphenólobus Michaùxii (Web.) Steph.	298
88	Trichocòlea tomentélla (Ehrh.) Dum.	284

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* Species marked * are not illustrated.

INDEX.

PAGE
Amblystegium 181, 193, 197
Anacamptodon 213
Andreaeaceae 37
Andreaea 37
Anomodon 161
Anthocerotaceae 257
Anthoceros 258
Apple Mosses 137
Asterella 253
Astomum 67
Aulacomniaceae 135
Aulacomnium 135
Barbula *23*, 105
Bartramiaceae 137
Bartramia 137
Bazzania 288
Beaked Mosses 202
Blasia 262
Blepharostoma 286
Bog Moss 135
Brachythecium 184, 197, 211
Broom Moss 79
Bruchia 66
Bryaceae 141
Bryum 141
" Long-necked 150
Buxbaumiaceae 56
Buxbaumia 56
Calliergon 185
Calypogeia 293
Campylium 187
Catharinea *16*, 52
Cephalozia 291
Ceratodon 70
Chiloscyphus 303
Cirriphyllum 204
Climacium 211

PAGE
Cololejeunea 280
Conocephalum 251
Cord Moss 129
Cylindrothecium. See Entodon.
Cynodontium 70
Desmatodon 112
Dichelyma 222
Dicranaceae 62
Dicranella 74
Dicranodontium 83
Dicranum 78
Didymodon 69
Diphyscium 57
Diplophylleia 284
Ditrichum 67
Drepanocladus 192
Drummondia 116
Encalyptaceae 114
Encalypta 114
Entodon 207
Eurhynchium 196, 202
Extinguisher Mosses 114
Fabroniaceae 213
Fern Mosses 164
Fissidentaceae 59
Fissidens 59
Fontinalaceae 219
Fontinalis 224
Fossombronia 266
Frullania 275
Funariaceae 129
Funaria 129
Geocalyx 296
Georgiaceae 38
Georgia 38
Glossary 304
Grimaldia 255

PAGE
Grimmiaceae.......... 87
Grimmia..............91, 92
Gymnostomum......... 102
Hair-cap Mosses........ 41
Harpanthus............ 297
Harpidium............. 192
Hedwigia.............. 88
Hepaticae............. 225
Homalia.............. 219
Hooked Mosses......... 192
Hygrohypnum.......... 130
Hylocomium.........168, 186
Hypraceae............ 170
Hypnum.........*26*, 172, 192
Hypnum, Water-loving.. 195
Jamsoniella............ 301
Jungermanniaceae.....267, 273
Jungermannia.......... 302
Kantia................ 293
Labels................ 9
Lejeunea.............. 279
Leucolejeunea.......... 280
Lepidozia.............. 287
Leptobryum........... 150
Leskeaceae............ 160
Leskea................ 161
Leucobryum........... 85
Leucodontaceae......... 214
Leucodon.............. 214
Lichens............... 1
Life History........... 10
Liverworts............ 225
Liverworts, Horned...... 257
Long-necked Moss....... 73
Lophocolea............ 296
Lophozia.............. 298
Luminous Moss........ 127
Lunularia............. 253
Marchantiaceae......... 235
Marchantia...........235–250

PAGE
Metzgeriaceae.......... 259
Metzgeria............. 260
Mnium................ 151
Nardia................ 302
Neckeraceae........... 216
Neckera............... 216
Notothylas............ 259
Odontoschisma.......... 299
Oncophorus........... 70
Orthotrichaceae......... 116
Orthotrichum.........*12*, 119
Pallavicinia............ 261
Peat Mosses........... 28
Pellia................ 263
Philonotis............. 139
Physcomitrium......... 132
Plagiochila............ 295
Plagiothecium........190, 205
Pleuridium............ 64
Plume Moss........... 172
Pogonatum............ 48
Pohlia................ 147
Polytrichaceae......... 40
Polytrichum.*2*, *14*, *17*, *18*, 41
Porella.............269, 278
Pottia................ 134
Preissia.............. 254
Ptilidium.............. 285
Ptychomitrium......... 89
Pylaisia............... 207
Radula................ 280
Raphidostegium. See Hypnum.
Reboulia.............. 256
Reindeer Moss......... 6
Rhacomitrium..........91, 97
Riccardia.............. 265
Ricciaceae............. 227
Riccia................ 228
Ricciocarpus........... 233
Scale Mosses.......... 267

PAGE
Scale Mosses, Thalloid . . . 259
Scapania 282
Schistostegaceae 126
Schistostega 126
Shaggy Moss 186
Slides 78
Sphagnaceae 28
Sphagnum 30
Sphenolobus 298
Splachnaceae 128
Splachnum 128
Tetrodontium 40
Thelia 163
Thuidium 164
Tortella 108

PAGE
Tortulaceae 100
Tortula 111
Tree Mosses 211
Trematodon 73
Trichocolea . . . . . Pl. XVI 284
Twisted Mosses 111
Ulota 117
Urn Moss 132
Water-loving Hypnums . . 195
Water Mosses 219
Water Moss, Beaked 196
Webera 57
Weisia 103
Weissia 117
White Moss 85

APPENDIX

The habitat key which follows is an attempt to enable a student to locate approximately the plants treated in this book without lens or other optical aid. But the student must remember that such keys are only approximate, as plants and their habitat vary greatly.

The key includes only the true mosses and the leafy hepatics. No plant without well defined stem and leaves should be sought here. Beginners are advised to read the introduction carefully before attempting to use the key.

After a plant is traced through the key, it must be compared carefully with the description and the illustrations.

If the student is uncertain as to which of two key headings a plant comes under, let him run it down through both. Also, if he fails to find his plant under what seems to be the correct heading, let him try tracing it through the heading that is most like the one chosen.

KEY TO THE GENERA OF MOSSES AND HEPATICS

Based Chiefly on Habitat

A

Plants growing on the bark of trees, usually more than a foot above the ground.

MOSSES

			PAGE.
1.	Regularly pinnate and pleurocarpous	*Thuidium.*	164
	Not regularly pinnate	2.	
2.	Plants with creeping stems from which arise many short lateral branches	3.	
	Plants very short, without creeping stems, rarely branching; acrocarpous *Ulota* 117	*Orthotrichum.*	119
3.	Acrocarpous, almost black	*Drummondia.*	116
	Pleurocarpous, dark to light green	4.	
4.	Glaucous-whitish; peristome almost white	*Thelia.*	163
	Not glaucous; peristomes not light colored	5.	
5.	Plants of deep woods	6.	
	Plants of orchards, shade trees and open groves	7.	
6.	Complanate-flattened; leaves wavy	*Neckera.*	216

Somewhat flattened; leaves not wavy.....*Anomodon.* 161

Leaves equally spreading, not complanate. *Leucodon* 214, *Brachythecium* 211.....*Hypnum reptile.* 180

7. Ends of branches curved.................*Pylaisia.* 207

Branches not curved; plants often near the base of trees..............................*Leskea.* 161

HEPATICS

Tiny plants, 1/25 inch wide or less. *Leucolejeunea* 280, *Lejeunea* 279.......................*Frullania.* 275

Plants larger. *Radula* 280, *Porella* 269, 280.

B

Plants growing on decaying wood or peaty humus, usually in moist or shaded places.

MOSSES

1. Fruiting plants consisting of seta and ovoid capsule, apparently without leaves..*Buxbaumia.* 56

Plants with very evident stem and leaves..... 2.

2. Acrocarpous.............................. 3.

Pleurocarpous.............................. 4.

3. Capsules pendent; leaves often large and broad, *Bryum* 141, *Pohlia* 147..............*Mnium.* 151

Capsules cernuous to erect, cylindric or sometimes ovoid-cylindric. *Georgia* 38, *Dicranella* 74, *Dicranum* 78..............*Oncophorus.* 70

4. Pinnate to tripinnate, fern-like. *Hylocomium* 168, *Hypnum* 172...................*Thuidium.* 164

Not pinnate.............................. 5.

5. Capsules cylindric and erect or nearly so. *Thelia* 163, *Entodon* 207, *Hypnum* 181...*Plagiothecium.* 207

Capsules curved, more or less cernuous. *Brachythecium* 184, 211; *Plagiothecium* 190, 205; *Hypnum* 172, 192; *Amblystegium* 181, 192, 197; *Eurhynchium.* 196, 202

HEPATICS

1. Very tiny; leaves scarcely visible without a lens. *Blepharostoma* 286, *Lepidozia* 287, *Harpanthus* 297, *Cepalozia* 291, *Odontoschisma* 299..*Ptilidium.* 285

Plants larger, more than 1/25 inch wide........ 2.
2. Leaves incubous. *Bazzania* 288.........*Calypogeia.* 293
Leaves succubous, strongly toothed or lobed *Geocalyx* 296, *Lophocolea* 296.........*Lophozia.* 298
Leaves succubous, entire, *Jamsoniella* 301, *Jungermannia* 302...................*Chiloscyphus.* 303

C

Plants growing on stones, mortared walls and base of trees.

MOSSES

1. Acrocarpous............................... 2.
Pleurocarpous............................. 6.
2. Plants blackish-green, hoary with whitish leaf tips; seldom found on trees. *Hedwigia* 88, *Rhacomitrium* 97, *Grimmia* 91, *Polytrichum piliferum.* 45
Plants as above but not hoary.................. 3.
Plants lighter green, not hoary.................. 4.
3. Capsules on a very short seta, at most barely beyond the perichaetial leaves. *Andreaea* 37, *Grimmia* 91, *Ulota* 117.........*Orthotrichum.* 119
Capsules on a much longer seta. *Pogonatum* 48, *Polytrichum* 41, *Ptychomitrium* 89, *Rhacomitrium aciculare.* 97
4. Capsules subglobose or pendent. *Bartramia* 137, *Philonotis* 139, *Polytrichum* 41, *Bryum* 141, *Leptobryum* 150, *Mnium* 151.........*Funaria.* 129
Capsules not pendent, erect to cernuous, more or less cylindric.......................... 5.
5. Leaves broad, ovate to oblong, often hair pointed. *Tortula* 108, *Encalypta* 114, *Desmatodon* 112, *Barbula.* 105
Leaves narrower, often long and slender. *Fissidens* 59, *Dicranela* 74, *Dicranum* 78, *Barbula* 195, *Oncophorus* 70...................*Tortella.* 108
6. Leaves widely spreading to squarrose when moist. *Campylium* 187, *Plagiothecium striatellum* 190.............*Hylocomium triquetrum.* 186

Leaves complanate. *Plagiothecium* 205, *Neckera* 216.................................*Homalia*. 219

Leaves not widely spreading or complanate.... 7.

7. Plants pinnately branched and fern-like in appearance. *Hylocomium* 168, *Hypnum* 172..*Thuidium*. 164

Not fern-like in appearance, nor regularly pinnate. *Amblystegium* 181 and 197, *Brachythecium* 184 and 197, *Hylocomium* 186....Hooked Mosses. 192

HEPATICS

Plants small, less than 1/12 inch wide. *Ptilidium* 285, *Lejeunea* 279, *Leucolejeunea* 280, *Cololejeunea* 280, *Lepidozia* 287, *Lophocolea* 296......*Jubula*. 278

Plants larger. *Radula* 280, *Jamsoniella* 301, *Diplophylleia* 284, *Bazzania* 288........*Lophozia*. 298

D

Plants usually partially or wholly submerged at usual water levels.

MOSSES

1. Plants with long floating stems.............. 2

Plants having stems usually less than two inches in length................................ 3.

2. Capsules wholly or partially concealed in the perichaetial leaves. *Dichelyma* 222..*Fontinalis*. 224

Capsules long exserted. (*Amblystegium*, *Drepanocladus*, not treated in this book).*Fissidens Julianus*. 62

3. Acrocarpous.............................. 4.

Pleurocarpous. *Amblystegium* 197, *Hypnum* 196, *Brachythecium* 197...............*Eurhynchium*. 196

4. Capsules globose or pendent.* *Philonotis* 139, *Mnium*. 151

Capsules erect; plants blackish. *Grimmia* 91, *Rhacomitrium*. 97

HEPATICS

Plagiochila 295, *Scapania* 282, *Chiloscyphus* 303.

---

[*] Sphagnum may be sought here.

E

Plants growing on soil of various sorts.

MOSSES

1. Plants light grayish green, sometimes tinted red or pink. *Sphagnum* 30............*Leucobryum.* 85
Plants blackish green. *Polytrichum* 41, *Pogonatum* 48.........................*Rhacomitrium.* 97
Plants not gray or blackish.................. 2.
2. Plants of dark holes and caverns, luminous. *Schistostega.* 127
Plants growing on animal matter or excreta. *Splachnaceae.* 128
Plants of dry open soil, often in sterile grassy places.**.............................. 3.
Plants growing on wet soil of all sorts.......... 10.
Plants of woods and shaded places............ 13.
3. Acrocarpous.............................. 4.
Pleurocarpous............................ 8.
4. Stems more than ½ inch in length. *Polytrichum* 41, *Dicranum* 78.....................*Tortula.* 111
Stems less than ½ inch long.................. 5.
5. Capsules without apparent seta. *Bruchia* 66, *Pleuridium* 64.....................*Astomum.* 67
Seta long and conspicuous.................. 6.
6. Capsules 4-6 angled................*Polytrichum.* 41
Capsules pendent. *Pohlia* 147, *Bryum* 141, *Leptobryum.* 150
Capsules horizontal to drooping, strongly wrinkled when dry...................*Funaria.* 129
Capsules erect, subglobose to top-shaped. *Pottia* 134.............................*Physcomitrium.* 132
Capsules subcylindric, erect to cernuous........ 7.
7. Capsules erect, little or not at all curved. *Dicranum* 78, *Barbula* 105...................*Tortula.* 111
Capsules strongly curved, sometimes wrinkled when dry. *Ceratodon* 70, *Trematodon* 73, *Dicranum.* 78
8. Pinnately branching..................*Thuidium.* 164

** Often wet in early spring.

Not pinnately branching.................... 9.

9. Leaves appressed when dry; branches julaceous. *Thelia* 163, *Cirriphyllum* 204, *Entodon seductrix* 207........................*Brachythecium.* 211

Branches not julaceus. *Brachythecium* 184 and 197, *Eurhynchium* 202................*Hypnum.* 172

10. Acrocarpous.................................. 11.

Pleurocarpous................................. 12.

11. Capsules subglobose, Philonotis 139; drooping, *Mnium* 151 or *Bryum*.................. 141

Capsules cylindric to subcylindric, erect to curved and cernuous. *Catharinea* 52, *Fissidens* 59......................*Aulacomnium.* 135

12. Branches complanate..............*Plagiothecium.* 205

Branches not complanate.................... 13.

13. Leaves widely spreading even when dry. *Campylium* 187.......................*Plagiothecium.* 190

Leaves appressed when dry. *Amblystegium* 192, *Brachythecium.* 197

Leaves secund, ends of branches appearing hooked.....................Hooked Mosses. 192

13. Acrocarpous................................. 14.

Pleurocarpous................................. 15.

14. Capsules 4-angled...................*Polytrichum.* 41

Capsules drooping. *Bryum* 141, *Leptobryum* 150, *Pohlia* 147...........................*Mnium.* 151

Capsules subglobose..................*Bartramia.* 137

Capsules ovoid and strongly unsymmetric. *Buxbaumiaceae.* 56

Capsules cylindric and erect. *Georgia* 38, *Pogonatum* 48, *Dicranum* 78, *Tortella* 108, *Barbula* 105, *Gymnostemum* (capsules too short to be truly cylindric)......................... 102

Capsules subcylindric, more or less curved and cernuous. *Pogonatum* 48, *Fissidens* 59, *Dicranella* 74, *Dicranum* 78, *Oncophorus* 70, *Aulacomnium.* 135

15. Pinnately branching and fern-like. *Thuidium* 164, *Hylocomium* 168................*Hypnum.* 172

Not pinnately branching.................... 16.

16. Complanate. *Plagiothecium* 205...........*Entodon.* 207

Not complanate.......................... 17.

17. Leaves widely spreading even when dry. *Campylium* 187, *Plagiothecium* 190....*Hylocomium.* 186

Leaves strongly secund. *Hylocomium rugosum* 186..........................Hooked Mosses 192

Leaves equally spreading, appressed when dry.. 18.

18. Capsules erect and cylindric. *Entodon* 207, *Brachythecium,* 210................*Climacium.* 211

Capsules subcylindric but curved and more or less cernuous. *Brachythecium* 197, *Eurhynchium* 202, *Hypnum* 172, *Calliergon* 185, *Amblystegium* 193...............*Cirriphyllum.* 204

HEPATICS

1. Leaves composed mainly of hair-like divisions. *Trichocolea, Ptilidium* and *Blepharostoma.* (See key on p. 273.)

Leaves not as above........................ 2.

2. Leaves scarcely distinguishable without a lens; plants less than 1/16 inch wide. *Lepidozia* 287, *Cephalozia* 291, *Odontoschisma* 299, *Nardia.* 302

Plants larger.......................... 3.

3. Leaves incubous. *Porella* 278, *Calypogeia* 293, *Bazzania* 288. (*Scapania* and *Chiloscyphus* forms may be sought here.)

Leaves succubous.......................... 4.

4. Leaves complicate-bilobed, the lower lobe the larger............................*Scapania.* 282

Leaves not complicate-bilobed............... 5.

5. Leaves entire or slightly emarginate. *Chiloscyphus* 303, *Jungermannia* 302, *Jamsoniella* 301..........................*Fossombronia.* 266

Some or all of the leaves strongly toothed or lobed. 6.

6. Leaves much longer than broad. *Lophocolea* 296, *Geocalyx.* 296

Leaves little longer than broad. *Sphenolobus* 298, *Lophozia.* 298

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